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## **A framework for river restoration planning : considering conceptual and structural perspectives from case studies of the Liao River in China and the Kalgan River in Australia**

Ye Sun  
*Edith Cowan University*

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# **A Framework for River Restoration Planning**

## **Considering Conceptual and Structural Perspectives from Case Studies of the Liao River in China and the Kalgan River in Australia**

**Ye Sun**

Thesis submitted in partial fulfilment of the requirements for Master of  
Science (Environmental Management), Edith Cowan University

March 2001

## USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

## **Abstract**

Over the last decade, restoration ecology has been considered a new paradigm for dealing with many of the environmental problems of river systems. It is also recognized that management decisions have a greater chance of being successful if they are based on a thorough understanding of a concept or a plan. A review of current studies on river restoration and river restoration planning revealed that managers and scientists have put a substantial emphasis on ecological science and technology in restoration, while many sociopolitical and economic elements have been de-emphasized. Besides this, understanding and experiences of river restoration, especially those of river managers and communities, is not well known so far.

This study commenced with the development of a framework for river restoration planning, based on a review of current knowledge of river restoration and planning processes. The framework was then used as an instrument to be compared with the understanding and experiences of river managers in two different countries. The aim of this study was to highlight the differences in acceptability of river restoration and river restoration planning between two different river systems in two different countries, and develop a framework for river restoration planning that includes these differences.

Using a heuristic inquiry, administrators responsible for two rivers, the Kalgan River in southwest Western Australia and the Liao River in northeast China, were interviewed to test if managers have comparable understandings of river restoration.

This study revealed that the understanding of the river restoration concept among river managers who participated in this research is influenced by sociopolitical, economic and ecological perspectives. For example, in Australia, managers see river restoration according to the kind of ecological benefits people will derive from it. To maintain the sustainable development of the river system is the main goal of river restoration. In contrast, in China, river managers would like to put more efforts on maintaining the balance between social, economic and ecological development, although, in the short term, pollution control is the first crucial step for river management.

The study also indicated that planning is influenced by different understandings of the concept of river restoration, by the existing administrative structures for river management, and by public participation in river management planning. For example, public participation plays an important role in river restoration planning in Australia, while in China, public participation was not considered appropriate or practical in the formulation of a plan even though more and more managers recognize its need and significance.

The final result of this study, a framework for river restoration planning, will supply some basic management guidelines for river managers. Future research can be conducted by using data from a project river to put the results of this study into practice, where case studies can be examined to test the robustness of the framework.

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To each of the above and to those who contributed to the success of my study in other ways, my sincere thanks.

To my parents for their patient support and encouragement.



## ***Declaration***

***I certify that this thesis does not, to the best of my knowledge and belief:***

- (i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;***
- (ii) contain any material previously published or written by another person except where due reference is made in the text; or***
- (iii) contain any defamatory material.***

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**ABBREVIATIONS AND ACRONYMS**

ABBREVIATION	TERM
AS	Australian Standard
BOD	Biological Oxygen Demand
CALM	Conservation and Land Management (Australia)
COD	Chemical Oxygen Demand
CS	Chinese Standard
DEP	Department of Environment Protection (Australia)
DPUD	Department of Planning and Urban Development
EIA	Environment Impact Assessment
EPA	Environmental Protection Authority (Australia)
EPB	Environmental Protection Bureau (China)
EPP	Environmental Protection Policy
ETC	Economy and Trade Committee (China)
GB	National Standard (China)
MfP	Ministry for Planning (Australia)
NEPA	National Environmental Protection Authority (China)
NRC	National Research Council (USA)
SC	State Council
SCEPG	South Coast Estuaries Project Group (Australia)
SEPA	State Environmental Protection Administration (China)
TCM	Total Catchment Management
WA	Western Australia
WAPC	Western Australia Planning Commission
WW	Waste Water
WWD	Waste Water Discharge

## **Chapter One**

### **Introduction**

#### **Overview**

River systems, described by Boon (1992) as the presence of unidirectional moving water, a continuously renewable resource, a rapid removal system for unwanted substance and a valuable store of potential energy, have always been used by and are important to humans. “Over the past 6000 years, humans have altered river corridors by over-engineering, pollution, over-abstraction and unsympathetic management” (Wade, Large & Waal, 1998, p.1). To some extent, rivers are just looked upon as drains. As a result of this abuse and lack of management, most rivers provide only poor water quality, with few ecological values and little in terms of amenity value. More seriously, many rivers are polluted from source to estuary and the natural cleansing action cannot cope (Kandiah, 1999). Meanwhile the demands for water are growing rapidly in response to industrialization, urbanization, increasing population and the rising standard of living throughout the world. The management of river systems is becoming more significant, increasingly urgent, and of fundamental importance in global, regional and local environmental terms.

Traditionally, river management has focused on improving in-channel systems rather than including a more holistic approach which addresses floodplain systems and takes account of the contribution that the emerging science of fluvial geomorphology can play (Holmes, 1998). In the last decade or so, fundamental concepts about and the need for integrated, interdisciplinary approaches to river management have gained wide acceptance (Gore, 1985). One of these is the concept of river restoration.

River restoration aims to restore a river or watershed to a condition that relaxes human constraints on the development of natural patterns of diversity. It is a process of improving the conditions in and around the stream channel so that natural functions are restored (Frissell & Ralph, 1998; Jennings & Harman, 1999).



Since the river restoration concept and its translation into practice are still in the early stages of development, people with different backgrounds may have different understandings and hence different criteria for decision making. This study introduces and discusses some understandings and ideas of the river restoration concept amongst environmental managers. This is taken from the viewpoint of two groups of people, Australian and Chinese managers, who have different cultural, social, economic, and political backgrounds. Their ideas have been discussed from an ecological, social, and economic perspective, since river restoration, as one aspect of river management practice, cannot be tackled without considering these perspectives. Although it is very important to understand and accept the concept of river restoration from different perspectives, translating it into practice and solving real problems is more important, since it is these actions that will improve the rivers. Therefore, it is necessary to identify a decision-making process that takes these perspectives into account. Developing a framework for river restoration planning is, therefore, an aim of this study.

Based on the literature, a draft framework for river restoration planning was developed at the commencement of this study. People involved in river management and planning were then interviewed. This study has focused on river-related agencies. Public works managers were targeted since they are in key positions to take the actions needed. Two rivers, the Kalgan in south west Western Australia and the Liao River in north east China, were selected and relevant managers were interviewed to find out their understandings of the river restoration concept and river restoration planning. Through their perceptions we hope to find a procedure that managers can follow during river restoration planning. This study also reveals the role that governments and the public play in river restoration planning.

A qualitative inquiry was used to access direct information on perceptions of river restoration and its planning to test this framework. An analysis of the information was undertaken by using an heuristic method. The recommendations draw on an analysis of the research and a review of the literature.

1.1 Background to the study

River systems have been used by humans more than any other type of ecosystem (Boon, 1992). The river system is an increasingly scarce resource requiring careful economic and environmental management. Throughout the world, the growth of populations, industrialization, the increase of global water demands (see Table 1), and other human activities have changed the diversity, extent, rate and permanence of rivers. Although the total quantity of water in the global hydrologic system has not been altered, the location and quality of the resources, as well as the timing of its use, have changed in both developed and developing countries (Frederick, 1992).

Table 1 Trends in Global Water Consumption by Major Category (km<sup>3</sup> per year)

Water usage	1900	1950	1970	1990	2000	% (2000)
Agriculture	525	1130	1850	2680	3250	62.6
Industry	37	178	540	973	1280	24.7
Municipal Needs	16	52	130	300	441	8.5
Reservoirs	<1	7	66	170	220	4.2
Total	579	1367	2586	4123	5191	100

Source: *Global Environment Monitoring System Global Freshwater Quality: A First Assessment*, Meybeck M., Chapam D., and Helmer R. Oxford: Basil Blackwell Ltd, 1989, p.306.

Traditionally river management efforts focused on the alteration of physical habitat characteristics on small spatial scales, often, for example, by placing logs, rocks or wire gabbons in a channel to create pools or collect gravel or by channelization to regulate flows or redirect flows. Soon management developed to further include flood control. With the development of industry, disposal sites for industrial wastes were monitored. Until now, most management activities focused on legal compliance to limit hazardous or toxic wastes, to achieve some water

quality standard, or to please the eye (Black, 1997). In order to deal with these problems wisely, it has been recognized that river problems will not be solved in the river alone, as these problems, for the most part, originate in the rivers' catchment areas. These are the reasons why the new concept, river restoration, based on holistic ideas of river management was introduced.

River restoration not only emphasizes water quality control and integration of the river system itself, it also addresses issues for both the river and its catchment. Today, more and more people believe that major efforts on river resources management should not only focus on protecting the existing ecosystem, but also on restoring those that are degraded (Whipple, 1996). River restoration as a tool for improving water quality and aquatic habitat is attracting interest globally (Jennings & Harman, 1999).

Progress in river management still suffers mainly from a lack of political commitment and from economic constraints. These factors and increasing competition for the economic, environmental and human health services provided by water suggest that more efficient and sustainable management of existing water supplies is needed (Frederick, 1992). It has been recommended that developmental and environmental values can be accommodated with careful planning (Frederick, 1992). River restoration planning as one type of administrative practice that involves scientific but also social, economic and political issues (Noss, O'Connell & Murphy, 1997).

Two rivers, in different countries, have been selected as case studies to reveal environmental managers' understanding of river restoration planning at an administrative level. One river has been chosen from south west Western Australia (the Kalgan River) and one chosen from north east China (the Liao River). Information on these two rivers is given in chapter three.

A river in China was selected because of the increasing water demand on the river which, in developing countries, is exacerbated by rapid population growth and urbanization (The World Bank, 1995). The development-environment dilemma points to the need for a new river

management approach in China. If a process that is suitable for China can be developed, it may have benefits for other developing countries. The Liao River was selected for this study because “it is the most polluted river in China” (National Environmental Protection Agency (NEPA)<sup>1</sup>, 1996, p.79). The Liao River catchment contains a large population and heavy industries, and is mainly polluted from point sources (in other words, pollution entering from well-defined points like pipes). The high demand for water from the Liao River and its serious pollution create an urgent need for river restoration. It is also representative of the condition of most rivers in China.

A river has been studied in Australia because “many of the Australia’s river have been degraded by direct interference with their channels and flow regimes, discharges of pollutants, and modifications to their catchment” (Lake & Marchant, 1990). While most river systems have been heavily modified in a developed country like Australia, resulting in aquatic ecosystem degradation (Lucas, Nicol & Koehn, 1999), high-quality water is often taken for granted (Frederick, 1992). Another reason for choosing a river in Australia is that river management practices in Australia often deal principally with survey and classification of the natural river system, and fail to recognize the causes of problems, or to consider remediation objectives other than the need for full restoration to the pre-disturbed state (Kapitzke, 1999). Therefore, it is also necessary to find a solution for this situation. The Kalgan River passes through a low level non-point source agricultural area which is considered to be a major contributor to degradation of water quality and ecosystem integrity in rivers. In this case, “agricultural production accounts for a large and growing share of water pollution by fertilizer, pesticides, salinity build-up and in some cases, heavy metals” (Dinar & Xepapadeas, 1998, p. 273).

These two rivers present a diversity of management issues. Countries differ in their water requirements and endowments, their poverty profiles, their institutional capacities, and the problems they face from environmental degradation in differing cultural, social, ecological and economic backgrounds (The World Bank, 1995). Therefore the two diverse systems provide a good test of the robustness of a framework for planning.

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<sup>1</sup> Since the beginning of 1997, the title of NEPA has been changed to “SEPA”--State Environmental Protection Administration

## **1.2 Significance and aim of the study**

River restoration is a new concept that emerged in the last decade and it is still in an early stage of development. Decision-making within restoration planning and the resulting works requires a strong ecological foundation and a comprehensive catchment management framework to ensure river health and environmental integrity. During the twentieth century "large-scale water projects have been widely promoted and subsidized as catalysts for economic growth" (Frederick, 1992, p.22). But major restoration activities have often been very small-scale, with few executed over long lengths of a river (Holmes, 1998). The National Research Council (1992) also suggests the spatial and temporal scope of most restoration efforts is far too small and attempts that involved large ecological landscapes are exceedingly rare. Most of the projects were actually partial ecological restoration works and full restoration was not attained. One reason why restoration still only happens on a small scale, despite the comparative richness of literature about comprehensive planning, is the lack of available literature on a management framework for large-scale river problems (Grigg, 1996). There are some studies on river restoration planning, but they are usually specific to particular rivers and most of them have a purely ecological focus.

A review of current studies was unable to find work on river restoration planning which took special consideration of social and economic views. No study has been found to reveal people's, especially river managers' understandings of the river restoration concept, or of river restoration planning based on their working experiences. No study has been found to reveal why people with different backgrounds, especially from two different countries (one developed and one developing), have different ideas on these same types of environmental issues. Indeed, a generalized framework for river restoration planning that can satisfy different understandings of river ecosystems, and the different environmental priorities associated with cultural difference from country to country, has not been developed and would have considerable value.

It is important to recognize that management decisions have a greater chance of being successful if they are based on a good understanding of a plan (Seal, 1995). In this study, managers'

understandings of the river restoration concept and its planning is presented, through which differences in acceptability of river restoration as a concept and river restoration planning approaches between two different river systems in two different countries are examined. A framework for river restoration planning that considers the relationship between the ecosystem and the socio-economic activities in river catchments is developed from the findings.

### **1.3 Structure of thesis**

This thesis consists of seven chapters, which present the purpose, the method and the results of this study.

In chapter two, the methodology for the study is explained in detail, including qualitative inquiry, data preparation and sampling, data display and analysis, the research questions and the limitations and the ethical considerations of this study.

In chapter three, detailed information on the two study-rivers is given. The Liao and the Kalgan River are presented briefly in terms of river system health and the social and economic constraints placed on the rivers.

Chapter four is a draft framework for river restoration planning developed by the researcher based on the literature review and used as an instrument for this study. Definitions of river restoration and some basic river restoration planning procedures are presented in this chapter.

Chapter five reveals the understandings of the river restoration concept from river managers and others from the two countries, from ecological, sociopolitical and economic perspectives. The differences found between the two groups are discussed.

Chapter six reveals managers' understandings of river restoration planning, including its goals and procedures. In this chapter the administrative structure and the role of government and community in river restoration planning is discussed.

The last chapter of this thesis is a synthesis. Requirements for modifications to the framework for river restoration planning (presented in chapter four) and based on information from participants (with different social, economic and ecological background) in chapters five and six, are presented as the outcome of the thesis.

## **Chapter Two**

### **Methodology**

#### **Overview**

This chapter describes the methodology of the study. It covers the design of the study and the description of data collection including the sampling procedure. The reliability of qualitative inquiry and the methods applicable to the use of instruments and interviews are discussed. Finally, the limitations, the ethical considerations and a discussion of researcher bias are outlined.

The following questions were formulated to guide the research process:

- Is the concept of river restoration acceptable to river managers in both Australia and China?
- How could a framework for river restoration planning be developed by examining the understandings and experiences of those who might be asked to implement or prepare such a plan?

#### **2.1 Qualitative inquiry**

Planners for water resources management are continually faced with decisions that must be made with considerable uncertainty (Watkins & McKinney, 1997). What will affect their decision-making? How do they use their personal experiences to solve the problems of uncertainty during the planning process? What can we learn from these personal ideas to find a framework for planning river restoration?

Qualitative study provides insight into the 'how' and the 'why' of human behaviour (Swanson & Chapman, 1994), using methods that allow the researcher to explore selected issues in depth and detail. There are many methods for qualitative inquiry and three basic forms of data collection:



in-depth, open-ended interview; direct observation; and, written documents, each of which can be accessed for different study purposes (Patton, 1990). In this research project, interviews were the principle source of data. A heuristic design was considered to be the most appropriate for this research, for the following reasons:

1. ‘The power of heuristic inquiry lies in its potential for disclosing truth. Through exhaustive self-search dialogues with others, and creative depictions of experience a comprehensive knowledge is generated, beginning as a series of subjective understanding and developing into a systematic and definitive exposition’ (Douglas & Moustakas, 1984. p.40). In this study, the interviewee’s understanding on river restoration will be revealed through open-ended questioning and compared with that of other interviewees. Different definitions will be generated to suit the conditions of each country.

2. “The rigor of heuristic inquiry comes from systematic observation of and dialogues with self and others, as well as in-depth interviewing of co-researchers” (Patton, 1990, p.72). Since the researcher has some knowledge of this concept and has some knowledge of relevant conditions in both countries, it will be possible to understand each side and to offer some solutions for each of them.

3. “Heuristics is concerned with meaning, not measurement; with essence, not appearance; with quality, not quantity; with experience, not behaviour” (Douglas & Moustakas, 1984, p.42). This study will reveal environmental managers’ of the river restoration concept and how environmental managers’s along with their social and economic background effect river restoration planning, through gently probing questions.

The experiential nature of this study justifies the heuristic approach.

## **2.2 Design of the study**

### **2.2.1 Framework development**

A framework for river restoration planning was developed as a test instrument in this study. A definition of the concept and the framework were introduced to participants after the initial contact and during the investigation period. The draft framework was developed from a review of the literature on river restoration concepts and river management planning. It is presented in chapter four.

Concepts of river restoration and the draft framework for river restoration planning were introduced to people working in different departments of the State Government and community groups in Western Australia (WA), and to people working for the Liaoning Provincial Government in China. The investigation sought to reveal participants' understandings about both the concept and the framework for river restoration planning. Their opinions and perceptions were important because these people influence the final decision-making processes and implementation of decisions regarding river management. In this study, the participants were asked to give their opinions about river restoration planning according to their own experiences. People working for different departments potentially had different management emphases according to their own working priority, therefore, although they were all working for the same government, their views differed. Based on a comparison of responses, a new framework for river restoration planning was developed and is presented in chapter seven.

### **2.2.2 Interviewee selection process**

The concept and the framework of river restoration planning were introduced to five people working in different departments of Liaoning provincial government. These departments are key agencies involved in or relevant to river management and include: Liaoning Provincial Environmental Protection Bureau, Liao River Management Group (led by the provincial

government directly), Agriculture Administration Bureau, Shenyang Environmental Protection Bureau, and the Hun River (the biggest branch of Liao River) Management Office.

In Western Australia, six people working in five different key departments of state government and one community group were interviewed. These departments include: Department of Environmental Protection; Western Australia Planning Commission; Department of Conservation and Land Management; Water and Rivers Commission; Agriculture Western Australia and one relevant community coordinating group. Interviewees were selected according to their familiarity with the Kalgan River.

Community groups do not have a strong influence on decision making in China. In fact, they are excluded from the decision making process and this will be discussed in chapter five. Therefore, a representative Chinese community group has not been included in this study. In Australia, however, the community is often involved in decision-making and implementation, warranting inclusion in this study.

Participants in the research were selected because of their knowledge of river management and planning experience, and the influence they have in river and/or catchment planning and decision making. Paul (1992) states that planners in regional government have often been central to the success of environmental initiatives. The opinions of government workers at the local level are important as they are the major decision-makers or planners. The participants' who were selected work in areas that are directly relevant to river restoration in their departments or community groups and are responsible for implementing restoration plans.

Snowball sampling identifies cases of interest from people who know people who know people who know what cases are information rich (Patton, 1990); this sampling technique was used to identify possible participants. Initially, a list of potential participants was developed by contacting an officer of each department mentioned above by phone and requesting they suggest someone whose work is relevant to this study. By calling them, some decided to accept the

interview and others made some suggestion on who might be the most relevant person to be involved. So, the most relevant people were interviewed first. Then, by asking them whom else should be interviewed, a direction was found to enrich the information for this study.

### **2.2.3 Interview process and data presentation**

Open-ended (semi-structured) interviews were used. Normally, this kind of interview is used when the researcher is familiar with the elements of the topic under investigation, but unable to consider or have knowledge of all possible responses in order to structure a set interview questionnaire (Morse, 1992). All interviewees were asked the same basic questions, which were determined in advance. All the questions were worded in a completely open-ended format. This ensured that the same type of information was sought from all participants (Patton, 1990). The open-ended interview process enables the researcher to ask the interviewee additional questions if new information emerges in the course of the interview, and to explore answers in-depth in order to come to a more substantial understanding.

In this study, two basic questions were asked in the same order. Some sub-questions were asked after the basic questions to obtain more in-depth answers and understandings. Questions and sub-questions used in this study are listed as follows:

1. What do you understand by the term “river restoration”?  
What is your understanding of the term “river restoration”?  
Is the concept of river restoration appropriate for the Kalgan/ Liao River?  
Do you think that there are any limitations to this concept?
2. What is your understanding of the term “river restoration planning”?  
What kind of procedure will you follow during the planning?  
What will be the main goals achieved? And what would be the objective?

Who should be involved in river restoration planning?

What role does government/community play in river restoration planning?

After finishing a plan, who will evaluate it?

Who will implement the river restoration plan?

What ideas do you have for sustainable development?

And what kind of role should it play in river restoration planning?

During the data collection process, an interview guide—which includes an letter of introduction (see Appendix A), a consent form (see Appendix B) and the interview questions (see Appendix C) were presented to the interviewees. The procedure for data collection was as follows:

The interview guide with information about the research project and the researcher was sent to participants. No additional information about river restoration was given at this stage, to limit any influence on the framework at the initial interview. A consent form was obtained prior to the commencement of each interview. For the willing participants, interviews were arranged at a time convenient to each participant by means of telephone, letter or email.

Eleven interviews in total were conducted. In order to ensure accuracy of information, all the tapes were reviewed by the researcher first before any transcribing to make sure all the information for this study had been covered in the interview. Two participants were re-interviewed to confirm some points of view. Five individual interviews were conducted in Australia initially (May - June, 1998) and one was conducted in Australia (in November, 1998) after five individual interviews were conducted in China (September - October, 1998).

The interviews were audio taped with the permission of interviewees. Each interview took approximately 45-60 minutes to complete. Notes were also taken during the interviews as a check list to confirm that information relevant to the research questions was covered by the interviewees. The audio taped data in Chinese were verbatim transcribed by the researcher, and then translated by a professional translator into English (in written form) and checked by the

researcher to ensure accuracy. The audio taped data in English were verbatim transcribed for ease of analysis.

Direct and indirect quotes were used in the text. For example, “*the river restoration work shall also cover the places where the river meets the sea while not only inland area*” (H: 143-144). Here, “H:143-144” means that the text is a direct quote taken from transcript of interview H, line 143-144. A sentence followed by (F) means that it is an indirect quote taken from transcript of interview F.

#### **2.2.4 Data analysis**

A content analysis method was used in this study since it focuses on human communication (Downe-Wamboldt, 1992). “Content analysis is the process of identifying, coding, and categorizing the primary patterns in the data” (Patton, 1990, p.381). The procedure for analyzing the data involved the following steps.

- All transcripts and notes were viewed together initially.
- The data were analyzed by grouping them according to the responses to the questions asked.
- Experiences (from each of the transcriptions) were interpreted and other dimensions of meaning, discussion and coding were added.
- Categories from one response were formed and these were then compared with other responses in order to find similar categories (for a detail of the categories, see Appendix D).
- Data in each category, the categories themselves, and the notes made from each transcription, were examined to identify possible themes.

Two overall themes were explored.

1. The degree to which the acceptability of river restoration concepts differs according to sociopolitical, economic and ecological perspectives.

2. Planning is affected/influenced by understandings of the concept, by administrative structure and by public participation.

### **2. 3 Limitations of the study**

The research undertaken is small in scope due to time and budgetary constraints. Some aspects, such as land use definition and sub-catchment management, for example, have not been considered due to these limitations.

Two different languages have been used in this study. English, as the second language of the researcher, may have limited the research somehow. For example, some personal ideas or experiences may not be expressed very well in English. In order to minimize this limitation, native English speakers were asked to check whether the opinions have been expressed accurately, and to help with editing the thesis.

The elements outlined above are considered to have limited the broader application of the study somewhat. However, while the number of people involved is small, their association with river management is significant. Therefore the findings are likely to represent the relevant people in their government or, at least, the managers who deal with these kinds of river management projects.

### **2.4 Ethical considerations**

The study was subject to a methodology which was approved by the Human Ethics Committee of Edith Cowan University.

In this study, people were informed in advance so they could decide if they would like to participate. They were also informed that they could withdraw at any time and that they had the

right to stop the interview at any time or to check the transcripts. There were no rejections from any interviewees for this study.

To guarantee confidentiality and anonymity, the specific government departments can not be seen in the analysis, and the interviewees have not been individually identified. Their opinions can not be considered to be the official opinions of their departments or their governments. Typed translations, transcripts and tapes have been kept in a secure place that only the interviewer can access. All the transcripts will be destroyed once this study is finished. All the tapes will be kept in a safe place for 5 years and will be destroyed after that time.



## **Chapter Three**

### **Background: the Liao River in Liaoning Province, China and the Kalgan River in South West Western Australia**

This chapter describes the natural, social and economic features of the Liao River in the Liaoning Province in China and the Kalgan River in south west Western Australia.

#### **3.1 Liao River**

The information presented in this chapter on the Liao River and its catchment is based on material from the following government reports: "Functions of Ground Water System in Liaoning" (Liaoning Environmental Protection Bureau, 1997); "Ninth Five -Year" Plan and Long -Term Planning of 2010 For Water Pollution Protection and Management of Liao River Basin within Liaoning Province (Liao River Basin Water Pollution Protection & Management Office, 1996); and, Annual Reports (NEPA/or SEPA, 1996-1998).

##### **3.1.1 Locality**

Liao River (see Appendix E) is one of the longest rivers in China. It is 1390 km in length and passes through the four provinces of Hebei, Inner Mongolian Autonomous Region, Jilin and Liaoning in north-east China. The Liao River system consists of Liao and Daliao Rivers and their tributaries, which together span a catchment area of 219,600 km<sup>2</sup>.

Liao River lies in the south east part of North East China. It is formed from the convergence of the West Liao River which rises in Guangtoushan mountain of Qilaotu mountains in Hebei province, and the East Liao river which rises in Hadaling mountains in Jilin province (see Appendix E). These two rivers join at Fudedian of Changtu County in Liaoning Province to become the Liao River. The Liao River flows into to Bohai Sea at the city of Panjin in Liaoning Province.

Dailiao is formed from the convergence of the Hun River, which rises in Gunmaling of Qingyuan County in Liaoning province, and Taizi River, which rises in Hongshilazi Mountain of Xinbin County in Liaoning province. These two rivers join at Sanchahe in Liaoning to become the Dailiao River. The Dailiao River flows into the Bohai Sea at the city of Yingkou in Liaoning Province.

The total length of Liao River in Liaoning province is 512 kilometres and the catchment in Liaoning province ( $116^{\circ} 53' - 125^{\circ} 32'$  East longitude,  $40^{\circ} 43' - 45^{\circ} 26'$  North latitude) covers an area of about 69,000 km<sup>2</sup>.

### **3.1.2 Climate and hydrology**

The climate of Liaoning province is characterised by temperate continental monsoon conditions, with a long dry winter, a warm wet summer and a short dry spring and autumn. The average annual precipitation is about 350-1200 mm with 70% of the annual rain falling between July and September. The average annual precipitation of Liao River catchment is about 44.7 billion cubic meters. The precipitation of Liao River catchment increases from north west to south east. The supply of water resource depends mainly on precipitation.

The volume of evaporation increases from south east to north west. The average annual evaporation rate is 1100-2500 mm/annum. In May the maximum evaporation rate occurs and is between 240 mm to 390 mm. In January, the evaporation rate is lowest, between 15 mm to 45 mm.

The run-off changes greatly with season. The annual maximum monthly run-off is in July and August when approximately 60% of the annual run-off is discharged. The minimum mean monthly run-off is in February when approximately 0.1% of the annual run-off is discharged. Floods occur mainly in July and August (90%). The total average annual ground run-off is 15 billion cubic meters.

There are a few natural lakes in Liao River catchment but water is stored principally by reservoirs and ponds.

### **3.1.3 Land use in Liao River catchment**

There are abundant and diverse land resources in Liao River catchment and these resources provide a broad foundation for social and economic development. The river is also a source of domestic water. Within the Liao River catchment, there are extensive tracts of productive soils. The area of cultivatable land is 45,018 km<sup>2</sup> constituting 20.5% of the total land area. The major crops in the catchment are rice, maize, Chinese sorghum, wheat, millet, peanut, soy bean and cotton. Liao River catchment is also a main agriculture and pasture area in China. The total output value of these is about 47 billion Yuan (1 AUD = 5.5 Yuan).

The Liao River catchment is mountainous with abundant and vast land resources. The eastern mountainous region, which covers 50,266km<sup>2</sup>, is mainly forested. The vegetation is categorized as mixed forest of needle leaf trees and broadleaf trees. The forest consists mainly of natural secondary forest. About 25,600 km<sup>2</sup> of the forest area is in the Liao River catchment. The major tree species are toothed oaks, birches, aspens, willows, Chinese lindens, Chinese pines, and Korean pines. East of the mountainous region of Liao River catchment, most areas are covered with sparse forest or grassy marshlands.

There are abundant and diverse mineral resources in Liao River Catchment. There are 70 kinds of ores including ferrous and non-ferrous metals and noble metals, which have been exploited, to date, from 692 mining sites.

### **3.1.4 Social and economic situation**

The Liao River passes through 65 cities or counties in the four provinces mentioned above. The population of the region is more than 30 million. The average population density in Liaoning

province is 338 persons per square kilometre. It has one of the highest population densities in China.

The Liaoning province contains several very important industrial zones with many large and medium-sized state-owned enterprises operating in the area. The economic value of the total industrial output within Liao catchment is about 327.4 billion Yuan, with Liaoning province producing the major component (305.3 billion Yuan). Many of these industries rely on access to the water resources of the Liao River.

Heavy industry plays an important role in the industrial structure in the Liao River catchment. The proportional gross output of the primary, second and tertiary industry is 18:96:65.

### **3.1.5 Environment: water quality**

The domestic and industrial demands placed on the Liao River over this century have played a major role in its declining water quality. Liao River passes through the industrial base of Liaoning Province of north east China, a major source of the pollution in the river. “It is the most polluted river in China” (NEPA, 1996, p.79). The industrial economy started at the turn of the century in Liaoning. It is concentrated in a few centers and traditional heavy industries are the majority accompanied by medium-scale modern industry. Table 2-a and 2-b show the total industrial waste water discharges in Liaoning, from which we can see the Liao catchment contains a large population and heavy industries, and is mainly polluted from point sources. One of the most important factors in river pollution is chemical oxygen demand (COD), and petroleum and volatile phenol, which belong to the organic oxygen-consuming type of pollution, are difficult to recognise. The high demand for water from the Liao River and its serious pollution problems, create an urgent need for appropriate river management.

**Table 2-a Waste Water Discharge (WWD) from industry in Liaoning, 1999**

*(unit: 10,000 ton)*

Total	COD	Petroleum	SSP	Volatile phenol	Hg (ton)	Pb (ton)	Sulfide
61281	15.69	0.245	28.904	0.0161	0.194	5.260	0. 0280

Source: *China Environmental Statistic Year-book, 1999* (SEPA, Beijing, 2000). p.8, p.88

**Table 2-b Population and industries of the 8 key cities along the Liao River in Liaoning in 1998.**

City	Population (million)		Main industries
	urban	Rural	
<u>Shenyang</u>	6.157	0.592	Chemical engineering; pharmacy; mechanism; beverage, electricity;
<u>Anshan</u>	3.173	0.223	Metallurgic industry is the main one along with mechanism and textile;
<u>Fushun</u>	1.903	0.368	Oil refinery; iron and steel product; chemical engineering; paper-making; coal product;
<u>Benxi</u>	1.449	0.114	Iron and steel; coal; mining (coal and iron); chemical engineering; electricity;
<u>Yingkou</u>	---	---	Paper making and light industries;
<u>Liaoyang</u>	1.725	0.061	Patrol chemical product; chemical engineering; paper-making;
<u>Panjin</u>	0.804	0.391	Oil field, chemical engineering; paper-making;
<u>Tieling</u>	2.325	0.631	Coal; paper-making; electricity; chemical engineering;

Source: *Liaoning Statistic Year-book, 1999* (China Statistic Press, Beijing, 2000)

In 1986, along sections of the Liao River, almost every aquatic organism within 100 kilometres was killed when over 1 billion tons of industrial waste were dumped into the river in a period of three months (90 days) (available online: [http://www.jhuccp.org/pr/m14/m14chap4\\_1.stm](http://www.jhuccp.org/pr/m14/m14chap4_1.stm)).

## **3.2 Kalgan River**

### **3.2.1 Locality**

The Kalgan River (see Appendix F) is one of the main rivers entering Oyster Harbour in the extreme south west of Australia, north east of the town of Albany in Western Australia. The Kalgan has its headwaters in the Stirling Ranges, and the River proper winds its way from the Upper Kalgan Bridge to the mouth at the north eastern corner of Oyster Harbour. It is approximately 110 km in length and drains an area of approximately 2450 km<sup>2</sup>, extending some 75 km inland from the coast.

The Kalgan River catchment extends north into the Shire of Plantagenet. Beyond the Stirling Ranges the area is mainly flat to broadly undulating plains, which are developed on marine sediments. The soils are predominantly sandy duplex with saline sub-soils formed on siltstones (Pen, 1994).

### **3.2.2 Climate and vegetation**

The Kalgan River catchment experiences a Mediterranean climate with a hot dry summer and a cool wet winter. The climate is temperate and mild, with an annual rainfall, from 900 mm on the coast and declining inland to 600 mm. The rainfall is mostly confined to the winter and early spring months. Evaporation is as high as 1400 mm inland, but as little as 50-200 mm on the coast (Department of Planning and Urban Development [DPUD], 1991). According to Pen (1994), the Kalgan River can be divided into an upper and lower region on the basis of climate and salinity of the river water. The upper region, which is relatively dry and prone to salinisation, covers 83% of the catchment. The lower region is much wetter and fresher.

Superimposed on this longitudinal pattern, the Kalgan exhibits a discharge which reflects the seasonal rainfall pattern. Strong flows over the winter/spring period and moderate to negligible flows over the summer/autumn period are experienced (Pen, 1994).

The main natural vegetation in the upper Kalgan catchment is woodland dominated by jarrah, wandoo, marri and yate, while that of the lower Kalgan is forest dominated by jarrah and marri, occasionally with yate and karri (Pen, 1994).

### **3.2.3 Land use in the Kalgan River catchment**

Agriculture is the main land use throughout the Kalgan Catchment. The river winds through agricultural land for most of its length although the steep banks of the river are generally still well vegetated (Seal, 1995). However, most of the Kalgan River Catchment has been cleared of its natural vegetation and developed for agriculture. Cropping and sheep farming are the main land-based activities in the upper part of Kalgan River catchment and sheep, beef cattle and some dairy farming are predominant in the lower section (DPUD, 1991).

The only areas of the Kalgan River catchment that retain significant stands of natural vegetation are located in the portions of catchment that fall within the Stirling Range National Park and Porongurup Range National Park (Pen, 1994).

### **3.2.4 Social and economic situation**

The Kalgan River passes through an area of low population density. There are less than six thousand people in the catchment. The foreshore land along the Kalgan River is a mixture of public land and private property, which is predominantly used for agricultural activities (Seal, 1995).

In the early days of this century, dairy and fruit, mainly apples, were the mainstays of the catchment's economy, and sheep and cropping also contributed. Since World War II, wine making, cropping, animal husbandry and aquaculture have been the major industries in the Kalgan area. In addition, mining plays a small but significant part in the catchment today. High quality silica sand for glass-making is mined in the east of the Kalgan catchment (Rowett & Pontin, 1998).

### **3.2.5 Sources of pollution**

Unlike Liao, the Kalgan River passes through an agricultural area with a low density population. Nevertheless, the Kalgan River is polluted, but in this case from non-point sources. Compared with point-source pollution, non-point pollution generally enters streams in run-off from surrounding land. In the context of Australia, non-point-source pollution is considered to be a major contributor to degradation of water quality and ecosystem integrity in rivers; the direct effects relate primarily to small streams and are then transmitted downstream to larger rivers (Webster, Golladay, Benfield & Meyer, 1992). The Kalgan River is typical of this problem.

Although there are several points of erosion on the Kalgan River area, the river valley is generally in a healthy condition (Pen, 1994). The main water system problems are salinisation of inland waters, the loss of natural fringing vegetation, eutrophication, sedimentation and contamination of inland waters.

Silt, salt, nutrients (from fertilisers and animal wastes) and pesticides are the main problems in this farmland catchment. Weed invasion, livestock grazing, trampling and frequent fires also contribute to the degradation along most of the length of the river. Urban run-off including litter, oil, petrol, heavy metals (for example, lead) and other chemicals spilled or dumped into drains (Pen & Majer, 1993) contribute to the decline of the river.



In 1988 and 1992, at least 42 and 39 tonnes of phosphorus entered Oyster Harbour from the Kalgan River (South Coast Estuaries Project Group [SCEPG], 1991; Weaver and Prout, 1993; Pen, 1994). The nutrient loss from the Kalgan River catchment reaches maximum levels during high intensity rainfall events in which massive runoff causes widespread erosion in the catchment(SCEPG,1991).

## **Chapter Four**

### **Framework for Planning River Restoration**

#### **Concept of river restoration**

Different definitions of restoration ecology can be found in a variety of sources. Basically it means: “the return of an ecosystem to a close approximation of its condition prior to disturbance.” (National Research Council, 1992, p.523). It “aims to return the degraded system to some form of cover that is protective, productive, aesthetically pleasing, or valuable in a conservation sense. A further tacit aim is to develop a system that is sustainable in the long term”(Hobbs & Norton, 1996, p.94).

Traditionally, river management emphasises water quality control and integration of factors within the river system itself. But it cannot be emphasised too strongly that river problems will not be solved in the river alone, as these problems, for the most part, originate in the rivers’ catchment areas (Mellquist, 1992). Therefore, a new concept with holistic ideas of river management is being introduced, bringing together notions of total catchment management and restoration ecology. “Restoration is different from habitat creation, reclamation, and rehabilitation, it is a holistic process not achieved through the isolated manipulation of individual elements. The holistic nature of restoration, including the reintroduction of animals, needs to be emphasized” (National Research Council, 1992, p.17). Unlike a traditional river management process, river restoration addresses issues for both the river and its catchment.

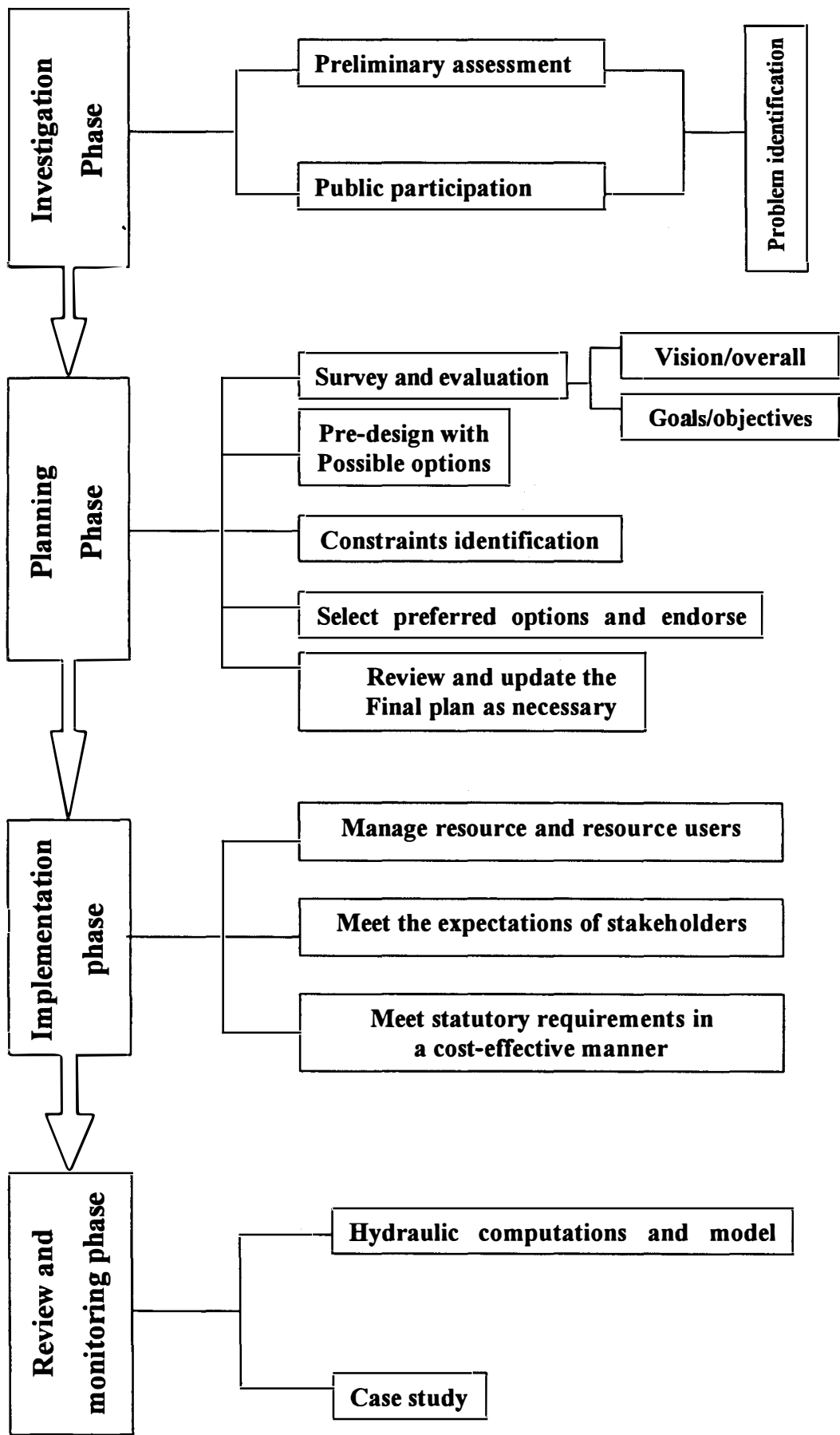
Given that health, vegetated riparian habitat and bottom lands are among the nation’s rarest habitats due to prior devastation - riparian habitat and bottom land restoration should be high national priority along with the restoration of the stream or river channel itself (National Research Council, 1992, p.8).

#### **4. 1 The framework**

Based on the river restoration concept, one river restoration program introduced by Larsen (1996) and other literature on river restoration, a framework for river restoration planning has been developed as part of this study. This framework is mainly developed for use by different levels of governments or agencies with direct management or regulatory responsibilities for rivers and their catchments or particular resources.

The framework for restoration planning, which is detailed below, consists of four phases: investigation; planning; implementation; and review and monitoring (see Figure 1).

Figure 1 Framework for river restoration planning



#### **4.1.1 Investigation phase**

The main focus of this phase is to identify processes that have resulted in degradation or decline of the river. It includes:

##### **4.1.1.1 Preliminary assessment - issues identification**

In the preliminary assessment, the general situation, past and present, of a project river and its catchment should be assessed to obtain an indication of the feasibility of a restoration project. Information on water resource management, landscape ecology and water quality should be collected. Economic and regulatory issues such as availability of land for purchase and boundary constraints should be examined. Previous plans for river management should be reviewed to help planners obtain a complete knowledge of the river and its management. Each of these ecological, economic and management components should be considered as part of problem identification for the project river and its catchment.

##### **4.1.1.2 Public participation**

The result of the preliminary assessment should be presented and discussed among representatives of the various authorities and professional disciplines that will be involved, for example, owner associations and the project sponsors (Larson, 1996). Meanwhile, the project should be open to the public since participation is an integral part of social assessment and can reveal issues of relevance at any stage in the process (Coakes, 1998). It will also encourage public involvement in implementing the project later.

Based on the assessed need for restoration and expectation of success, the terms of reference for planning should be supplied by the end of this phase. The goals and the extent and limitations of the project will be identified.

#### **4.1.2 Planning phase**

The planning phase is one of “preparing an action plan to address the issues, setting out the means by which and the time-scale within which the agreed ‘vision’ will be achieved” (Gee and Jones, 1995, p.476).

For this and other projects, visions/overall goals, objectives and actions should be specified at the time of planning. The visions and objectives then will become the basis of the assessment criteria for the project as a whole that reflects both human behaviour and needs, and also the biological needs of project species.

It should be re-emphasised at this point that the planning of river restoration is distinct from engineering in that it cannot be limited to the space between the riverbank; it must include the entire flood plain. It requires consideration of some of the ecological features of the whole river valley, which means that river restoration is a holistic process not achieved through the isolated manipulation of individual elements of a river (Larson, 1996).

This phase emphasizes the issues and processes to be included in a river restoration plan. The processes include:

##### **4.1.2.1 Survey, evaluation and model image establishment**

Since the goals and the extent of the project will determine the type and comprehensiveness of field investigation, goals and specific objectives should be identified first.

###### **4.1.2.1.1 Vision or overall goals:**

“The primary goal of river restoration is to re-establish the variety of habitats required for the natural diversity of biota in and along the river ”(Larson, 1996, p.129). It mainly consists of:

## **Conservation of Nature**

The re-establishment and preservation of the natural environment is the dominant objective of restoration. Thus, restoration planning requires consideration of some ecological features of the whole river valley. For example, one of the goals to be achieved in the Rhine Action Program, for the Rhine River in Europe, declares: "the ecosystem of the Rhine must become a suitable habitat to allow the return to this great European river of higher [trophic] species which were once present here and have since disappeared, such as salmon" (International Commission for the Protection of the Rhine Against Pollution, 1987, 1991). This localised example indicates the need for different goals to achieve the requirement of different ecological features in different rivers.

## **Water resources management**

Since "a river and its floodplain are intimately linked, they should be managed and restored as integral parts of an ecosystem (National Research Council, 1992, p.8). In the past and today, one of the main purposes of river management is to reduce flooding. Water quality, as another paramount factor to deal with, is also very important in restoration planning. If the water quality is poor because of discharges of wastes from human activities, re-naturalization is doomed to fail and any money spent would be better invested in waste-water treatment (Larson, 1996). It is also necessary to improve the water quality by reducing pollution originating from direct inputs, such as industry, and municipalities as well as non-point sources such as the atmosphere and agriculture (International Commission for the Protection of Rhine Against Pollution, 1987, 1991).

## **Landscape planning**

On one hand land use within a catchment influences "the transport of contaminants to a river and affects the magnitude and frequency of disturbances" (Milner, 1996, p.212). On the other hand

restoration targets can extend from local improvements in appearance near settlements to the re-naturalization of a whole stream. The targets and their extensions and the changes made by these improvements will affect the landscape. Hence the need to emphasise that the land and water are a hydrological continuum and must be managed together” (Newson, 1992, p.385). Re-naturalization should include the creation of areas suitable for human activity of various kinds, including recreation. In this task, the conflict between the ecological requirement of undisturbed habitats and that of free human activity must be considered and a suitable compromise must be found (Larson, 1996).

The fundamental goal of aquatic ecosystem restoration is to return the river to a condition that resembles its natural pre-disturbance state as close as possible (National Research Council, 1992). However, the restoration of a system to pre-disturbed conditions is impossible to achieve since no two parts of any single pristine river system are ever 100 per cent similar in either structure or function. Therefore, restoration planners must recognize that restoration is an exercise in approximating prior conditions (National Research Council, 1992).

Overall goals should be prioritized so that project designers and evaluators have a clear understanding of the relative importance of each goal. The vision or overall goals will guide the whole river restoration planning process. Different rivers will require different goals and a set of different plans to accommodate their specific issues. For example, a plan for pollution control, a plan for fish preservation and reintroduction or a plan for preservation of macrofauna the river, might be designed for achieving the goals.

#### **4.1.2.1.2 Objectives**

Objectives that give the specific characteristics of the river restoration process are derived from the goals. They define, for example, the requirement for water quality and aquatic biota. Different objectives should be defined for different project rivers. Deciding the specific objectives in order to achieve the vision/overall goals of river restoration requires baseline data



from ecological data collection and analysis. The ecological data will help to formulate the options and management guidelines of a project.

Issues requiring consideration are given in Table 3.

**Table. 3 Issues requiring consideration for survey and evaluation (s-e) in setting objectives for the plan.**

s-e 1: River morphology	<p>Survey of the river bed: size distribution of sediment, strata, erodibility, natural armouring</p> <p>Investigation of sediment budget: sediment transport, sediment balance</p> <p>Morphological development: information from old maps.</p> <p>Adoption of sediment transport model: calibration, range of applicability</p>
s-e 2: Landscape ecology	<p>Mapping of present and previous usage of the corridor</p> <p>Mapping and evaluation of biotopes: wetlands, dry lands, other biotopes</p> <p>Mapping and evaluation of tributaries: morphological features, sediment delivery, water discharge</p> <p>Mapping of stand characteristics: soil properties, humidity, climate, potential for natural revegetation</p> <p>Changes in stand properties due to human activities: water management, artificial fertility, reversibility</p>
s-e 3: Water resources management	<p>Investigation of ground water management: limits on water level</p> <p>Investigations of flooding and flood protection</p> <p>Establishment of a register of sewage and waste-water discharges</p>
s-e 4: Limnology	<p>Survey of the river, its tributaries and still waters</p> <p>Chemical and physical parameters</p> <p>Fish fauna, invertebrates, macrophytes</p>
s-e 5: Special investigations	<p>Potential for re-establishing plant societies</p> <p>Biotope requirements of (especially) endangered species: grassland bird, fishes, amphibians</p>

Source: *Larsen, P. (1996). Restoration of River corridor: German Experiences.* In Petts, G. & Calow, P (Eds.) *River Restoration* (p.140) London: Blackwell Science.

“Water resources analysts recognize that water resources planning should be comprehensive and multi-objective in nature, in contrast to planning centered on a single objective, such as flood control or irrigation” (Whipple, 1996). Objectives should be defined in accordance with the primary goals of river restoration and based on the analysis of the ecological data mentioned above as well as other social and economic information.

The objectives provide a focus for a model image which is tailored to the situation for each project river. The model image will serve as a benchmark to describe an idealistic goal that can guide the planners. Historical maps and aerial photography (including inferred images) would be used (Larson, 1996).

This stage should also outline realistic objectives for re-establishing species and ecosystems functions.

#### **4.1.2.2 Pre-design with possible options for management**

The pre-design should explain the achievable goals and means of reaching them under the constraints imposed by water management, ecology, engineering and the economy (Larson, 1996). Methods and techniques to reverse or ameliorate the degradation or decline of a river should be developed in this stage.

#### **4.1.2.3 Constraints identification**

Both the ecological limitations on restoration, and the socioeconomic and cultural barriers to the implementation of a plan should be recognized. This means, during this stage, different options for action should not only be analyzed in an ecology context, but also in social, political, culture and economic contexts.

#### **4.1.2.4 Select preferred options and endorse plan**

##### **Final design and acquisition of permits:**

The project option that is chosen from the pre-design phase is further elaborated and described in the text and supplemented by detailed drawings. The final design is determined while maintaining close communication among the various specialists and the project initiator. “Evaluation before the fact (pre-project evaluation) can help a decision maker identify the project most likely to provide the greatest ecological benefits at the lowest cost, an especially important consideration in an era of budgetary constraints and enormous environmental challenges” (National Research Council, 1992, p.64). The final design documents comprise: a written report; a set of drawings; hydraulic computations; design and stability analysis of hydraulic structures; cost analysis, and reports and comments from experts.

The project of river restoration cannot succeed without public understanding and support: “the public has become increasingly aware of the need for restoration of river-riparian ecosystems and numerous public and private agencies and citizen groups are likely to initiate further stream and river restoration projects”(National Research Council, 1992, p.12). All these require citizens, government, recreationalists, farmers, business, fishers, tribal groups and environmental representatives to participate in the planning process. The best solution is that people who will be involved in implementing should also be involved in planning.

At the same time, education is also one of the most important part of the restoration plan and should be done before the implementation phase. Seal (1995, p.49) identifies the importance of education:

understanding how the waterways function and how they are affected by human activity helps to develop an appreciation of, and a desire to care for, the environment. The

opportunity exists to increase this awareness by providing more opportunities for people to learn about the waterways and thus to appreciate their value.

Wade, Large & Waal, (1998, p.6) claim the education "should be targeted not only at planners, decision-makers, politicians, farmers/landowners, practitioners, water managers/engineers, pressure groups and scientists, but again also at the public (all age groups)".

#### **4.1.2.5 Review and update**

Review and update the final plan as necessary.

#### **4.1.3 Implementation phase**

The implementation phase marks not only the end but also the beginning of a planning process. Implementing plans formulated at strategic and operational levels involves translating objectives into actions. It has three main components (Kay and Alder, 1999):

- managing resources and resource users;
- ensuring that stakeholder expectations are met; and
- meeting statutory requirements in a cost-effective manner.

Keeping a balance between these three components is the key to guaranteeing the effective implementation of a plan. Practical techniques for implementing the restoration goals should be used. This phase also includes the implementation of supervision for the proposed measures. The success of restoration depends greatly on the supervisory participation of experts during the execution of the plan.

#### **4.1.4 Review and monitoring phase**

Monitoring is the main process used to insure the plan is reaching its goals and objectives: monitoring key system variables, assessing progress of restoration relative to the agreed-upon goals, and adjusting procedures if necessary (Hobbs & Norton, 1996). The evaluation of a completed restoration project (post-project evaluation) is vital to ensure the permit requirements of a mandatory restoration project (for example, one performed for mitigation purposes) have been achieved. "It is also essential for people conducting discretionary restoration projects to know how effective their efforts have been" (National Research Council, 1992, p.64).

Monitoring should include both supervision of the development as well as observation of changes to ecological indicators, including, river morphology flow regime, the changes of ground water levels, flora and fauna and human use and impacts. Survey and data collection of initial conditions after implementation will help to evaluate whether the plan has been successful.

#### **4.2 The comprehensive characteristics of river restoration**

It is known that a plan can not be formulated successfully without the consideration of the following issues, some of which will be discussed in more detail: public involvement; total catchment management (TCM); economic and social impacts; adaptability; and, political impacts.

TCM should be considered to be fundamentally similar to river restoration. TCM refers to the coordinated and balanced use of the resources within a water catchment to achieve sustainability. These resources comprise land, water, vegetation and soils.

Evaluation criteria to assess options should include ecological criteria and water quality and human use criteria (National Research Council, 1992). For dependable evaluations, assessment

criteria must include both structural and functional attributes of the ecosystem. It is expected that these criteria will be applied during the decision making in accordance with the specific situation of a project river.

In order for pre-project evaluation of prospective restoration alternatives to be comprehensive, economic and social impact factors such as risk and social equity (“the incidence of benefits and costs for different classes of people affected by the project” National Research Council, 1992, p.68) must be considered along with ecological effects.

The restoration programs themselves must be adaptable and persistent, because high and low flows affect restorative efforts and are not completely predictable or controllable (National Research Council, 1992, p.175).

Restoration would be an ideal method of river management, but might well be impossible for purely practical and budgetary reasons (Allen and Hoekstra, 1992, p.297). Therefore, decisions have to be made, with economic and political considerations sometimes overriding scientific judgment. For example, population as an element should be considered.

### **4.3 Check list**

Finally, a check similar to the National Research Council (1992) check list is suggested as an efficient way to conduct a river restoration plan (Table 4).

**Table. 4 Restoration Checklist**

<b>Project Planning and Design</b>	
1	Has the problem requiring treatment been clearly understood and defined?
2	Is there a consensus on the restoration program’s mission?
3	Have the goals and objectives been identified?
4	Has the restoration been planned with adequate scope and expertise?
5	Does the restoration management design have an annual or mid-course correction point in line with adaptive management procedures?
6	Are the performance indicators-the measurable biological, physical, and chemical attributes directly and appropriately linked to the objectives?
7	Have adequate monitoring, surveillance, management, and maintenance programs been developed along with the project, so that monitoring costs and operational details are anticipated and monitoring results will be available to serve as input in improving restoration techniques used as the project matures?
8	Has an appropriate reference system (or systems) been selected from which to extract target values of performance indicators for comparison in conducting the project evaluation?
9	Have sufficient baseline data been collected over a suitable period of time on the project ecosystem to facilitate before-and-after treatment comparisons?
10	Have critical project procedures been tested on a small experimental scale in part of the project area to minimise the risk of failure?
11	Has the project been designed to make the restored ecosystem as self-sustaining as possible to minimise maintenance requirements?
12	Has thought been given to how long monitoring will have to be continued before the project can be declared effective?
13	Have risk and uncertainty been adequately considered in project planning?
14	What is the range of stakeholder involvement in decision making?



<b>During Restoration</b>	
1	Are environmental and economic goals appropriate?
2	Based on the monitoring results, are the anticipated intermediate objectives being achieved? If not, are appropriate steps being taken to correct the problem(s)?
3	Do the objectives or performance indicators need to be modified? If so, what changes may be required in the monitoring program?
4	Is the monitoring program adequate?
<b>Post-Restoration</b>	
1	To what extent were project goals and objective achieved?
2	How similar in structure and function is the restored ecosystem to target ecosystem?
3	To what extent is the restored ecosystem self-sustaining, and what are the maintenance requirements?
4	If all natural ecosystem functions were not restored, have critical ecosystem functions been restored?
5	If all natural components of ecosystem were not restored, have critical components been restored?
6	How long did the project take?
7	What lessons have been learned from these efforts?
8	Have those lessons been shared with interested parties to maximise the potential for technology transfer?
9	What was the final cost, in net present value terms, of the restoration project?
10	What were the ecological, economic, and social benefits realised by the project?
11	How cost-effective was the project?
12	Would another approach to restoration have produced desirable results at lower cost?

Source: *National Research Council. (1992). Restoration of Aquatic Ecosystems. Washington, D. C. National Academy Press.*

## **Chapter Five (Theme 1)**

### **Accepting the Concept of River Restoration: Ecological, Sociopolitical and Economic Perspectives**

#### **Overview**

The process of river restoration involves the application of various techniques "to replicate the hydrological, morphological and ecological features that have been lost in a stream due to urbanization, farming, or other disturbance" (National Research Council, 1995, p.524).

River restoration, as mentioned in chapter one, is a process of restoring a river or watershed to a condition that relaxes human constraints on the development of natural patterns of diversity. Further, it is a process of improving the conditions in and around the stream channel so that natural functions are restored (Frissell & Ralph, 1998, Jennings & Harman, 1999). Like most environmental management methods, river restoration should also be considerate of and implemented from a wide range of perspectives including sociopolitical, economic and ecological issues.

People with different social, cultural, political, economic or educational backgrounds are likely to have different understandings of the concept. Further, some researchers show that ordinary people prefer to trust the logic of their own senses (Slattery, 1998). It is very important to recognize the roles that environmental managers play in practice. People's understanding of river restoration will influence their decision to accept or reject the concept and their willingness to put the concept into practice. Other researchers show that improving people's scientific understanding can lead them to better understand issues and their consequences, and therefore to modify their behaviour to maximize nature conservation (Slattery, 1998). Consequently, it is necessary to get clear ideas of environmental managers' of river restoration concepts in order to determine the degree to which they will be accepted.

Basic concepts of river restoration has been presented in Chapter Four (the framework) already. This chapter, will discuss the level of understanding of this river restoration concept from two geographically and culturally distinct groups of people, to see if this concept is acceptable and if people are willing to put it into practice. One group is from Australia (developed country) and the other group is from China (developing country). Their understanding of river restoration is examined from social, economic and ecological perspectives.

### **5.1 General understandings of the river restoration concept**

In this study, the concept of river restoration was introduced and was discussed during the interviews to find out interviewees' ideas or understandings of it. Due to different personal backgrounds and working situations, it was found that interviewees did not share the same ideas or understandings of this concept. Their understanding of the concept shows acceptability from different perspectives. Two typical responses from Chinese interviewees were:

**River restoration is to restore functions of a river.**

**River restoration is to restore a river in both quality and quantity.**

One interviewee believes that *'in a developing country like China, river restoration concerns mainly the pollution of rivers, especially industrial and agricultural pollution. Rivers should be controlled and restored to their original environmental volume'* (A: 1-4). Another interviewee believes that under Chinese conditions, there were two issues that should be given priority in river restoration in the short term. *'The first one is the restoration of water flow, and the second is the restoration of water quality'* (B: 71-72). *'In the long term, the concept of river restoration in Liaoning Province refers to the restoration of surrounding ecological environment and the restoration of the water quantity and quality of the river itself'* (B: 86-88). The detailed explanations of these understandings/ideas from different perspectives will be presented later in this chapter.

Australian responses that emerged to the river restoration concept were typically of the following nature:

- River restoration means to have the waterway systems (including the wetlands systems) at a better level of condition than they are now, so sustainable management is achievable.
- River restoration should reach the right balance to maintain biodiversity and also to enhance people's lifestyles.

One Australian interviewee states that '*river restoration is a two pronged approach... working on the catchment and working on the river and the immediate environs of the river*' (E: 148-150). Another suggests that maintaining biodiversity is a major purpose of river restoration (K).

From these different perspectives it can be concluded that people from different backgrounds tend to have a different understanding of the river restoration concept. It is important to reveal how these elements affect people's understandings. In this chapter, understandings from interviewees and the researcher of the river restoration concept along with the acceptability of it are presented and discussed from ecological, sociopolitical and economic perspectives.

## **5.2 Ecological perspective**

Traditionally river management was limited to water quality and flood prevention. These two factors were the primary reasons for river restoration in the past. "Water quality concerns include sedimentation, elevated nutrient levels, bacteria, low dissolved oxygen, increased temperatures and loss of aquatic habitat" (Jennings & Harman, 1999, p. 359). Today many people view river restoration as aiming to rehabilitate the physical and biotic processes of a river in a way that is conducive to the progression of ecosystems toward their natural state (Lucas, Nicol & Koehn, 1999).

In Australia, many river management programs have stemmed from practices associated with traditional objectives for flood and erosion control. More sustainable stream management practices, encompassing ecological issues (Kapitzke, 1999) are now advocated. Through this study, this phenomenon will be compared with river restoration in China.

### **5.2.1 Ecological perspectives in south west Australia**

As a starting point, this section elaborates the kinds of problems managers are concerned with, in the context of the Kalgan River catchment area (in addition to those mentioned in chapter three).

Firstly, most of the problems in southwest Western Australia are from agricultural areas where fertilizer can leach rapidly through the sandy soil and end up in rivers. Some managers believe that these problems are caused by over-use of fertilizer (F). They comment on the role of the fertilizer companies: it is not in their interest not to sell fertilizer (F & K). *'What has to happen is that the fertilizer companies have to move towards fertilizer management as a business, supplying technical advice'* (K).

Secondly, in south west Western Australia, much of the land is privately owned, therefore, *'people who own the land think that they can do what they want'* (E: 132). In cases like this, *'some irresponsible farming practice can't be always avoided, which will lead to the degradation of lands and rivers'* (M). For example, *'many country people actually let the animals go down and graze and drink the water, which of course does a lot of damage to the rivers'* (E: 119-121).

From the above it can be seen that there are some social and economic problems people have to face while dealing with environmental problems. For example, driven by economic imperatives, combined with a government commitment to industrial/agricultural development and expansion, the management of Australia's water resources has, until recently, focused upon meeting the needs of consumptive users (Allan & Lovett, 1997). Another issue is the lack of awareness about river management. In a developed country like Australia, high-quality water is taken for granted

(Frederick, 1992). In a situation like this, it is very important for people to understand that if the ecosystem can't function very well, both industry and agriculture will be affected. Most managers who were interviewed believe that we can't fix a river without fixing the other components (F, G & K). It's like a jigsaw puzzle: *'we have to look at the whole thing because the river is only a small part of a big picture and land use in general requires critical thinking and a change of attitudes. The degraded river is really only the result of rather poor practice'* (F).

#### 5.2.1.1 Understandings of the river restoration concept

In south west Western Australia, *'environmental water requirements basically consist of leaving sufficient water in the environment to maintain ecological process'* (K). Therefore, generally speaking, river restoration is understood as a way to restore watershed systems (including wetland systems) to a better condition than they are now to reach the right balance in maintaining biodiversity (K).

For the Kalgan River, it is thought that restoration is necessary and acceptable. The reasons provided for this are: *the Kalgan River catchment is largely cleared'* (G: 31); and,

*the river itself is too salty... It's just a drain now to get rid of the surface water...In the long term, I'm personally convinced that we are going to suffer...Farmers, farming practices will suffer and that leads to degradation of the river systems and everything* (F: 78-103).

*Most of our rivers and wetlands are degraded and they could be sustainably managed at a low level of beneficial use. But we would lose quite a bit of the biodiversity of the south west* (K: 101-103).

*River restoration is trying to develop plans which improve the quality of rivers and their associated habitats...to maintain the nature conservation values* (G: 163,192).

Others emphasise river restoration as a catchment-based process:

- *In Australia we would probably look at it on a catchment basis...look at obviously what's in the catchment. In terms of a river, you would need to look at the catchment for water quality...look at what's contributing to your river and what's getting out there...look at rehabilitating a reasonable distance back (E: 92-131).*

The understanding of river restoration also includes an aim:

*To maintain flora and fauna of the river and the estuarine system as well as landscape value ... to maintain the abundance of biodiversity (J: 247-250).*

*Obviously there would be conservation and land management because river restoration would also provide a whole range of wildlife corridors and conservation and land management, particularly for the Kalgan (D: 392-295).*

Of course there is not much reference to industrial pollution management from the Australian group in south west Western Australia, most of the river problems are from agricultural activities. In the past, rivers were used for watering livestock, resulting in the riverbanks being destroyed along with some of the fringing vegetation. It has been broadly accepted that fringing vegetation acts to prevent erosion, filters out suspended solids during flood events and assimilates nutrients carried in runoff (South Coast Estuaries Project Group, 1991; Weaver and Prout, 1993). Therefore, in 1992, fencing of the Kalgan River as the first step towards managing the streamline (Pen, 1994) was commenced. This decision was made primarily to prevent livestock from destroying the banks of the river, and the results and the feasibility of this method are generally supported by the government and the community. However, doubts about the effectiveness of this action have been expressed by some managers, according to their own working experiences as well as their understanding of river restoration.

Managers who support this project think that fencing is an effective action to improve the river system environment and is the first step of river restoration. Some of the following reasons were given in support of this claim.

Compared to many other areas in Australia and also other areas in the world, this region has only recently been developed, which means that:

*in terms of its degradation, it possibly hasn't gone as far as in other places in Australia, or other places in the world. As the degradation time line has not got too far, we hope that the approach of simply fencing and keeping stock out of these areas [will] ... let the ecological balance restore naturally and some native species come back and re-colonize these areas'* (D).

Keeping cattle and sheep out with fences will, at the least, improve water clarity:

*if you've got cattle wandering around in streams, they will certainly pollute streams, they will stir up the mud, increasing turbidity and degrade the waterways* (G:274-276).

Although the majority of the fencing along the Kalgan River has been completed, some people think that there are patches, for one reason or another, that will never be fenced and for which it will not be necessary to fence (D & F) for one or more of the reasons.

- Economic concerns (which will be discussed later in the part on economic perspective).
- Government policy in previous times led to significant clearing. Under these policies, some places have been completely cleared, so that there is no native vegetation left (D & J) and no need to place fences.
- Some farmers feel that they are not degrading the river. *'They are looking after it although it is not fenced'* (F).



- On farmland, if you have a heavy rain, there are little creeks everywhere, a lot of water is already in these creeks, which goes straight into the river anyway. *'While fencing the river is great and looks good and makes you feel good, the benefits are really minor'* (F). The *'idea of river restoration should be to focus on the first order streams and have them all fenced off and re-vegetated before tackling the higher order streams'* (D: 97-99). So, if the total farming practice, where many problems start, is not changed, it doesn't matter if you've got your river fenced or not, the problems will not be solved (F).
- For fire management *'there are not continuous corridors of vegetation that could spread from the top end of a catchment all the way down to the bottom end'* (D: 284-285) and this is another impediment.

### 5.2.2 Ecological perspectives in China

Compared to river restoration in developed countries, in China, river management concerns mainly the pollution of rivers, especially industrial and agricultural pollution, because high-quality water is essential to good health and important for economic development (Frederick, 1992). For the managers who participated in this study, the river restoration concept is accepted as a long-term ecological goal. The restoration concept is interpreted as water quality control and quantity recovery to meet river functions, which means that rivers shall be controlled and restored to their original volume in the long term. Managers do not think it is necessary to restore a river back to pre-disturbance state and, at least in China, this will not be a short-term achievement. For instance:

*River restoration does not mean to restore a river to its original natural status, but to restore its functions and water quality objectives...It includes the restoration of both water and surrounding environment...By the term of river restoration, we mean to restore water quality of a river...The number one priority is to improve water quality with a very good vegetation environment in the whole river region. With such a meaning, the concept of river restoration is applicable to Liao River* (C: 3-14).

*If we stick to the definition of the developed countries, river restoration can hardly be achieved in our country, and it is not necessary to recover the river to its natural status. However, we can set up some reservation zones to protect some rare animals and plants (L:22-26).*

*According to my understanding, the concept of river recovery shall have two aspects, one is the restoration of use-value of the river, the other is the restoration of the quality of the river. The latter depends on environment management. Another thing we should not overlook is the ecological benefit of the river. The river has its influence on the biology, even the climate of the region. If the river ceased its existence or is destroyed, the biological link of the region will be destroyed. Therefore, river restoration has both biological index and environment index.... The unlimited use of the water of the Liao River for irrigation or for urban uses is not allowed. The water quantity of the river shall be maintained to protect the ecological environment of the river, thus we can have access to its water forever (B: 186-199).*

*Different river sections shall have different standards. The water for irrigation shall have different standards than water for drinking (B: 122-124).*

The reason why river managers think that the concept of river restoration is acceptable is because Liao River is severely polluted and water quality should be restored to meet the requirements of various water functions.

Talking about how to operationalize water pollution and water resources protection, managers also introduced some work that they have done. Similar to the standards in Australia, the Chinese government made “*Environmental Quality Standards for Surface Water* (GB 3838-88). It was approved by NEPA on April 5, 1988. These standards are applicable to all sorts of surface water bodies within the territory of the People's Republic of China, such as rivers, streams, lakes,

reservoirs, which posses certain using functions" (SEPA, 1998, p.1). Depending on the uses and protection target, surface waters are classified into five functional categories (see Table 5).

**Table 5   Functional Classification of Water Bodies**

Category	Mainly applicable to
I	The source of the water bodies and the national nature preserves.
II	Class A water source protection area for centralized drinking water supply, sanctuaries for rare species of fish and spawning grounds of fishes and shrimps.
III	Class B water source protection area for centralized drinking water supply, sanctuaries for common species of fish, and swimming zones.
IV	Water bodies for general industrial water supply and recreational waters in which there is no direct contact of the human body with the water.
V	Water bodies for agricultural water supply and for the general landscape requirements.

Source: Selected Environmental Standards of the People's Republic of China (1979-1997). Beijing, SEPA, 1998, p.1

From the above, it can be seen that river restoration should include the restoration of both the water and the surrounding environment in the long-term (A). One priority is to improve the water quality with a very good vegetated environment of the whole river region. The interviewees in China agree that it is very difficult to recover the original status of the river exactly, but at the least, restoration should be able to meet the minimum requirements of the river functions for people, for drinking water, irrigating and sight-seeing.

*The general goals of the river restoration differ with the function requirements of different rivers. If a river is used as a source of drinking water, the requirements of water quality*

*shall be emphasized. If it is for sightseeing, the harmony and integration with surrounding ecological environments shall be emphasized. If it is used for agricultural purposes, the requirements on medium water quality and richness of river flow shall be emphasized (H: 41-46).*

An interesting response to the river restoration concept combined ideas from the Western and from the Chinese approach, for example:

*The concept of river restoration contains extensive meanings. It covers all the efforts and activities for the restoration of the original river functions which have been changed by human activities or natural forces. This includes water quality restoration, which means the control and prevention of the pollution of water, ecological restoration which involves tree planting and similar activities aimed at the restoration of water loss and soil erosion caused by the destruction of forest and plants upstream. Such recoveries include restoration of a single function and complete restoration (H: 24-31).*

*Liao River control, is actually part of the general goals of Liao River Restoration. At present, the number one task for Liao River control is to prevent the river pollution caused by industrial and urban waste water and to protect the water sources for drinking water. Only after this, can we realize the next goal, which is to restore the ecological balance in Liao River catchment, and to establish a good ecological environment in this region (H: 86-91).*

*I also think that river restoration is the only approach to solve river problems' (H: 93).*

This is quite a unique response compared with those of the other Chinese managers, who focus on pollution control almost exclusively. The response indicates that long-term ecological development ideas may be dominant in river restoration or any other environmental planning in

China in the future, with the introduction of further management concepts to Chinese river managers.

Biodiversity as an important ecological component needing to be taken into account in river restoration was not given much attention by the Chinese participants in this study.

### **5.2.3 Case study comparison and discussion**

A river is a complex ecological system. It is not always in balance due to changes of nature itself and the effects of human activities. This kind of system contains a variety of physical, chemical and biological components which interact through complex process (Seal, 1995). A common view, from both south west Western Australia and north east Chinese interviewees, is that rivers are not in a balanced situation with development and they are getting worse. Both groups of interviewees emphasised that the main purpose of river restoration is to enhance peoples' lifestyles. The Australian managers tend to be more concerned about the restoration of biodiversity, however.

There are several other issues that have been drawn from this study. One is that the managers from Australia show much concern about the issues of fencing along the river, while this issue is not been mentioned by Chinese participants. Another one is that no one from south west Western Australia mentioned any problems caused by industry, unlike their Chinese counter-parts who must consider the methods for controlling industrial pollution in Liao River area. The Kalgan River, in contrast, passes through farming land.

After critical analysis of all responses, it has been found that one issue not addressed in the original framework (the instrument) is the importance of riverine function. There are several reasons to explain the failure of the instrument to cover this aspect. First, the instrument was developed at the very beginning of this study and based on literature review. At that period of time, there were not many studies undertaken on river restoration and its planning. Secondly,

even though some research had been conducted on river restoration, few discussions of the water system functions were presented (Black, 1997). Through the interviews, it has been recognized that the functions of river system and its restoration should be given adequate consideration during planning.

Although the economic development and rapid population growth in China has had implications for considerable environment change, there are still some areas in the countryside with fresh air, great sunshine and clean water. However a number of social and economic problems impact on China's countryside. An under-developed economy has contributed to poor living conditions, including a lack of houses, transportation, education and medical care. The basic living requirement of people can no longer be met from the ecosystem. In under-developed regions, an "ideal" system can provide for people's living needs as well as the potential needs of the future generations.

Can river restoration achieve an ideal ecosystem? First of all, environmental managers should understand and respect the limits of nature. Secondly, they should strive for a balance between economic development and ecological needs. A river should be used and managed according to the requirements of its different function zones, and for different human activities. It is reasonable therefore, that *'the definition of river restoration shall suit the specific conditions of a country at a certain time, to suit its technological conditions and economic strength'* (L: 25-27).

In the past, attempts at river restoration have been conducted largely in isolation of other ecological factors, often concentrating only on one component of a river system, such as flow. As river systems are complex, variable and interacting environments with a diversity of habitats, river restoration must consider all components.

Rivers should be restored in terms of both their qualities and the quantity of water. By the restoration of river quantity, it means that water of a river is abundant and is available throughout the years without suffering from drying or flooding. To achieve this, river restoration should

include actions like forest conservation, forest protection and forest planting. Some other actions to enrich the water flow by way of water and soil conservation should be included as well. In a place like south west Western Australia, where rivers pass through agricultural and sheep farming lands, it is necessary to fence-off the rivers to protect the fringing vegetation from the effects of livestock grazing and trampling. Fencing will help to prevent the degradation of riparian vegetation, which eventually leads to severe erosion, downstream siltation, pollution and ultimately the loss of productive farmland (Pen, 1994).

The water management methods employed by developed countries normally entail a large amount of data, with uniform sampling methods over long-time periods in all regions. These requirements are difficult to meet in developing countries. In China, for example, people tend to give priority to solutions for water pollution and pollution sources.

In 1998, the floods of Yangzi River in China were not primarily caused by high precipitation and the lack of the maintenance of the dams along the rivers. The precipitation was not, in fact, the highest in recorded history, but the severe flooding was due to the destruction of the ecosystem along the river during this century, particularly from the clearing of forests upstream. It was one of the worst disasters that has ever happened in that area. Now, managers believe that it was mainly caused by mismanagement of the catchment. People have begun to understand that river problems cannot be solved by building dams, rather the solution lies in the restoration of the whole ecosystem.

In China, one of the main concerns is to identify the level to which the water quality needs to be improved and maintained to support ecosystem functioning (see Seal, 1995) and the different social and economic uses. Another concern is to minimize the impact of human activities on the ecological functioning of rivers.

In cases like the Liao River, the goal of river restoration should be to return the river close to an ecological balance or condition by using ecological management technology. In aiming for

ecological balance, the role of nature and its processes and functions are considered. However river restoration is a process which can only be achieved step by step.

One issue to emerge from the study of the river management projects in these two countries is that managers pay a lot of attention to gathering background data but fail to use these data to predict an outcome in terms of the project (J). In failing to articulate the goals of the project, the public are unlikely to realise the benefits, and potential public interest and involvement may be lost.

### **5.3 Sociopolitical perspectives**

Today, we face environmental problems from pollution and the degradation of ecosystems. These problems are the result of the interactions between economic and social development. They occur not only because of the economic activities but also because of social problems especially increasing population pressures. The methods that are adopted to solve environmental problems depend on the level of technological and economic development. Therefore, environmental problems have to be considered and solved as social and economic problems.

River restoration as an environmental issue is not only about conservation, biodiversity, and ecosystem maintenance; it requires sociopolitical support. Different countries have different sociopolitical structures and perspectives which influence the different emphases to particular issues. Experience in developed countries shows that in order to solve environmental problems, a set of legislative and administrative systems have to be established as well as specific administrative authorities.

As one of the world's most rapidly industrializing countries, China is in a unique period of trying to achieve twin goals of economic development and environmental protection. It began developing a regulatory framework for environmental management and pollution control after the first United Nations Conference on Environment in Stockholm in 1977 (Sporfford, 1995;



1996). But, as a result of the large population, rapid economic growth, inadequate technological and managerial capacities, and low environmental awareness among both decision makers and the public (Wu, 1997), the scope of ecological damage has expanded in the last two decades, and environmental problems have impeded economic development and even harmed human health in some areas. If current trends continue, China faces the threat of large shortages of fresh water in the next century. The most important goal for river management in China is to provide safe drinking water. As it stands, the situation in China has been identified (Table 6).

**Table 6    Percentage of the population with access to safe drinking water and sanitation in China**

Safe Drinking Water			Sanitation		
Urban	Rural	Total	Urban	Rural	Total
87	68	72	100	81	85

Source: *The World Bank, “Clear Water, Blue Skies: China’s Environment in the New Century” (1997). Table 2.2, p.20*

**5.3.1 Sociopolitical issues in south west Western Australia**

There are also some political and social issues affecting the practice of river restoration in Australia, even though people in Australia tend to consider it to be a sound ecological process.

First of all, ‘ *in a democracy people would like to be able to do more or less what they want*’ (E: 191-192). It is the political system and the government has to respect that view. Consequently, the government has to practice river management subtly, through, for example, education. Another problem for river restoration in Australia is private land ownership, which limits controls on landowners (E). Some people who own the land think that they can do what they want with it. Because of ownership rights, ‘ *it is difficult to get farmers to co-operate*’ (F: 282), and this is where managers have to work carefully with the landowners, particularly farmers, to

try and convince them that it is not in the best interests of the community as a whole, that the river is being destroyed (E).

One solution to the problems associated with private land ownership is to revert the sections of land along rivers into public ownership. This solution involves both social and economic considerations and actions. The state government of WA is now working towards returning river frontages to public ownership and to take responsibility for the care of the rivers (E), but farmers are not always happy about what the government has done for them (F).

However most people believe that *'if you have a property with a river running through it, you have to give up a certain portion when you subdivide the land, for the common good'* (E: 141-142). As a return, *'they do get some sort of incentives'* (E: 170).

### **5.3.2 Sociopolitical issues in north east China**

Population pressure is one of the main characteristics of developing countries. As the country with the largest population in the world, improving living conditions is the number one issue people and government face. Unlike developed countries, the dense population covers nearly every area in China, especially in river regions, including in the upstream areas. The living standards of the people who live in these areas is very low and efforts to improve their quality of living through productive work and other human activities, inevitably cause ecological damage and river pollution. Should government stop their efforts to achieve economic development since it inevitably impacts on river ecosystems? Do they deserve to live in poverty because they are living in the upstream area (L)? The answer is "no". Does this mean the river restoration concept is not acceptable in China? How do we solve the conflicts?

In most cases, policies for river restoration/ management will bring benefits to the society since river restoration will increase the water resources that are available and will improve the quality for the future (A & H). A set of policies and regulations based on a sound understanding of river

management/restoration should be formulated as experience shows they play an important role in protecting the river from environmental destruction, and, in achieving sustainable development. With regard to policy making generally, river restoration is totally acceptable (A).

In some cases though, some managers are concerned that if the policies or regulations are strictly followed and applied to enterprises, the enterprises will have high operation costs (L). The result will be that some factories will have to shut down, as is the current situation in China where the fate of development and the lives of the people who are working in those factories is brought into question. One interviewee suggests that *'the answer to these questions lies in the policies of economic compensation, without which the environment control plan can never be achieved'* (L: 71-73).

At present, China is in the process of reforming both its economic and political systems. Even though there are many issues that the government should consider, increasingly, river managers agree that *'a country can hardly be developed unless it has a very good environment'* (A: 175-176). Otherwise long-term development cannot be maintained, because the waste of resources raises the production cost and the product is consequently less competitive. Persistent economic development requires low costs and low consumption of materials and energy, and a high quality product.

In China, industries are usually eager for quick success and instant benefit (A & L). It is especially bad when some of the government leaders have this approach. It is important to judge an enterprise not only by its profit, but also by economic benefit and market development. In China now, the most polluting enterprises are closed, merged or transformed because of their poor economic benefit, not as a result of their environmental impact (A, H & L). Consequently, if these industries are not managed or re-developed by the government, they can not compete in the market economy and will ultimately disappear.

### 5.3.3 Comparative analysis

The concept of river restoration should be acceptable as it can provide social benefits, including, for example, the knowledge that there will be a reduction of impacts to rivers. This will improve river usage in other areas, like tourism, and promote greater access to the resources (see Lucas, Nicol & Koehn, 1999).

Enhancing people's lifestyle is the main social benefit that river restoration should aim. However, different countries have different social systems, which will affect the way restoration is conducted.

The responses from managers from both countries indicate that the government is perceived as the main agency responsible for river degradation, from poor policy-making in the early days and limited improvements in water policies since. Governments need strong environmental policies, not only to provide health and ecosystem protection but also to stimulate the economy (Gardiner and Portney, 1994). However, the managers from the two countries hold different views on the role of government. The managers from south west WA suggest that government policies should be tough and control should be put in place to make sure development will not destroy the environment. Chinese managers on the other hand think that very strict policies will block development.

Farmers in China were not interviewed, we can't see their attitudes towards government regulations. After interviewing a community group in Australia, it must be true that some farmers have bias against government regulation in both countries. Farmers are struggling to make a living and they don't want bureaucrats dictating to them and telling them how to make a living. This perception of the bureaucracy in each country and the conflicts between government and the people working on the land, may prevent the acceptance of the other's position. On the other hand, it is difficult to get farmers to change farming practices that are continuing to

degrade the land and that are not addressing catchment management issues (F). Furthermore, farmers' attitudes to farming practices affect the implementation of river restoration.

People's attitudes towards economic and ecological development effect the implementation of river restoration. Managers in both countries claim that *'with any development you are getting a net loss almost all the time, it has to happen and we have to accept some of that'* (E: 445-447). But they will try to minimize it. If we want to restore a river, we have to improve land management techniques, and we cannot develop land without limitations. Through careful land management we can actually improve the situation of a river and provide economic and ecological benefits for society. These are the ultimate goals of river restoration.

#### **5.4 Economic perspectives**

Generally speaking, economic restraints to ecological management exist mainly in developing countries. A lack of funds is the primary constraint for water management programs in developing countries, since, limited economic resources must satisfy other urgent demands from the public sector (Frederiksen, 1996). Developed countries have greater financial capacity to initiate controls in the upstream regions of rivers. Measures can be taken to restrict access to an area that needs to be restored, through the establishment of preservation zones. In developing countries nature protection is often considered to be a luxury and there is a perception that more distant frontiers are more suitable for nature conservation (The World Bank, 1992). A developing country like China may have the economic capacity to carry out river control (restoration) projects, to recover the self-cleaning function of the rivers and to recover other functions of the rivers to some extent, but the process is limited. The term "river restoration" is interpreted to include finding measures so that the river can provide the services needed for the development of the economy with regard to production, irrigation (C), or to recover a river to a status that is beneficial to people's living and economic development (L). All these need strong

financial support, a sound economic environment and specific policies that recognize the economic value of river resources.

#### **5.4.1 Economic and ownership issues in south west Western Australia**

Unlike China, many parts of the riparian strip along the Kalbar River are privately owned. In order to ensure better management, and in addition to cooperation with the local community, the government must purchase some river lands (E). *'In country areas, it is a bit difficult to get these foreshores'* (E: 220), even when governments assist financially and implement special policies for river restoration projects. Although Australia is a developed country, there are still economic difficulties associated with river restoration. For example, in the fencing project mentioned above, *'government has schemes in place to provide for farmers to fence off the important area...but there's not enough money for all farmers to fence off all their creek lines'* (G: 278-280). In other developed countries, "many landholders are unenthusiastic about fencing riparian land because of reduced access to stock watering, maintenance cost and loss of productive land" (Gippel & Collier, 1998, p.277). Also, as discussed before, in the south west region, most river problems are created by agricultural activity. Modern farming practices in Australia have been driven by economics for over fifty years, despite the resultant landscape degradation and declining water quality. Also because of the low fertility of many Australian soils, agricultural production benefits from the application of fertilizers (Gippel & Collier, 1998, p.272). Yet as one interviewee responded to the proposal of stopping fertilizer use: *'if you don't pour on fertilizer, you don't spray it for every sort of fungus, insect, wogs or everything, you don't get crops, you go bankrupt'* (F: 61-63). A vicious cycle is created. Farmers will not respond to being told to stop using fertilizer because of the likely loss to income from this change to farming. The cycle is created by making short-term production the priority.

Some managers in Australia note that economic reasoning *'will always happen and that the ecological sustainability will go and eventually our ecosystems will collapse'* (E:456-457). Thus,

economic concerns are a main issue that affect the restoration of natural areas, including rivers. It is thought that *'it would just cost far too much for anything ever to be achieved'* (G: 176-177). One interviewee suggests the process needs to be driven by economics, *'it needs to be driven by a product that the farmers are getting a return on'* (G: 178-179).

#### 5. 4. 2 Economic issues in China

"Most of China's nature reserves are located in poor rural areas with limited opportunities for economic development. People depend heavily on natural resources for subsistence and cash generating activities" (The World Bank, 1992, p.137). As interviewee (L) claims developed countries are financially capable of river restoration, while it is different in developing countries. The interviewee suggests that when the economy of China is developed to a higher level, then a higher goal in river restoration can be set up. Without guaranteed economic support, higher goals can never be achieved. (L) also mentioned that it is not difficult to achieve the goals technically, their technical people can easily reduce the COD discharge of each plant to meet the discharge standards, given enough money. However, developing countries are not strong enough financially. Further, river managers have to work hard to prevent other administrative agencies causing new pollution by emphasizing economic development (L).

River restoration in China, *'shall be aimed at recovering the rivers to a status that is beneficial to people's living and economic development. Just as human rights, which mainly refers to the rights of human living conditions and their continuous improvement, our purpose for river restoration shall also be aimed at this'* (L: 5-11). Therefore, special policies, including policies for river restoration, which are adjusted for the economy and are beneficial to all parties, should be made as soon as possible to suit the particular social requirements in China. To achieve this, all government departments, including the economic department, are asked to address both the economic benefit and the reasonable use of resources, since sustainable development can only be achieved if the resources are used most efficiently. *'Seeing only the economic benefit and*

*ignoring the waste of resources will only cause the shortage of resources'* (A: 149-151). This approach should be acknowledged by managers.

In China, more than eighty per cent of the population is located in the countryside where the living standards are very low and access to food is most important. However, some food growing activities have economic, social and environmental consequences. In the city of Liaoning (especially in Liao River catchment), one interviewee (B) mentioned there is a large area of floodplain, which is flooded during heavy rain and planted during the dry season. Many farmers plant their crops on such areas, mostly long-stalked crops such as sorghum or maize, which are easy to manage. The harvest time of these crops is in October in Liaoning province, which comes after the rainy season of July and August. When a flood occurs, the crops are growing very high, blocking the discharge of the flood. Flood prevention is one of the most important goals for river restoration, so they have to be cleared away. But at the same time, these flooding lands provide a living for the local farmers. In order to solve this economic, social and environmental problem, the government promotes the idea "to turn tall crops into short". The idea is to plant wheat or vegetables instead of sorghum or maize, which can be harvested before the flood season, and the river course can be cleared for flood discharge. In addition, the agricultural department which takes responsibility of the clearing of Liao River, is required to give allowances (compensation) to the farmers who plant wheat each year. However, even though the government knows that river course clearing is important for river restoration, they are not able to afford it, or are unwilling to do it. The example suggests that, from an economic perspective, it is difficult to practice river restoration in China. There are still many Chinese officials that adamantly hold that economic development must come before environmental protection, yet even they have started to notice that from the economic view, rivers should be restored to provide services to the development of the economy in respect of production, irrigation and so on (B).



It can be seen from the responses of the interviewees that, in China, environmental management investment is driven mainly from the government. Some loans are also used, but the enterprises do not share the investment. Government investment in river restoration comes from a government subsidiary and pollution discharge taxes. The investment is considerable, however both government and enterprises have tended to focus on making money at the expense of most other things. 'China is too poor' for a variety of familiar reasons (Recuenco, 1999). Essentially, people believe that if the policy is strictly applied to the enterprise, the enterprise will not be able to cover the operation costs.

In addition to the investment from government, industries and local governments are increasingly seeking sources of funding through the "polluter pays" principle. One possible approach is to increase pollution charges. In the meantime, industries also hope that foreign investment will continue to provide funds supporting their ambitious plans to solve the problems of pollution.

#### **5.4.3 Comparative analysis**

Economic issues are very important for river restoration since the implementation of sounder practices will produce more sustainable and cost effective management (Lucas, Nicols & Koehn, 1999). Also, 'economics is often used to evaluate the consequences of decisions or to assist in the selection of new projects' (Huppert and Kantor, 1998, p.585).

The situation in China is by no means unique. The state of rivers is understandable, given the poverty that has long dogged developing countries (Recuenco, 1999). Therefore when environmental managers interpret the river restoration concept in the case of developing countries, case studies in China are relevant and applicable.

On the one hand, economic growth can exacerbate pollution and pollution related problems in developing countries. Until the last decade, for example, it was thought that developing countries could postpone environmental improvements while awaiting economic growth/development (Krupnick, 1992). In China, this perception still exists and sometimes influences decision-making.

On the other hand, rapid economic growth in China can create opportunities to reduce pollution. Without the creation of wealth, it will be impossible to restructure and modernize the industrial sector, develop cleaner sources of energy, build needed urban and environmental infrastructure, and clean up existing contaminated sites (Spofford, 1996).

One issue that is common to both Australia and China, is the perception that government spending does not reach the area of need. As one interviewee said: *'governments gauge a lot of their results on how much money they've spent'* (F) but they often failed to explain what kind of social, economic and ecological benefits have been achieved and sometimes people wonder where the money went. It is understandable that people think that most of the project money is spent on wages for advisers, for their four wheel drive vehicles, for conferences or reports and that very little of the money reaches the target area or does anything practical. It is important for the government to invest money on river restoration, and on improving the environment, not only on making the government feel better.

There will be conflict between achieving environmental objectives and achieving economic ones. One solution is to promote the idea of conservation that if we can save money for the future, we can also save the resources for future generations. It is important not to repeat the mistakes of some developed countries where development was achieved at the cost of the environment so that current environmental problems are so large that are very difficult to solve.

## 5.5 Conclusion

Several limitations with the river restoration concept have arisen during the course of this work. Even though all river managers interviewed for this study agree that river restoration is a concept which brings some fresh ideas to river management, we are in the early stages of developing the concept and there are limitations, which have been noticed by the researcher and by the participants. These are:

- The literature on aquatic restoration, such as the Restoration of Aquatic Ecosystems (National Research Council, 1992), tends to focus on the rehabilitation, reclamation, or restoration of biological components rather than non-biological ecological functions (Black, 1997).
- River restoration is a qualitative concept which makes it difficult to decide to what degree/extent river restoration should be achieved. And *'I don't think that there is any expectation that the system would ever be restored back to what is used to be'* (D: 339-340).
- There are some economic and social impediments like the willingness of the farming community to respond to new practices and finance (D).
- Time-scales are difficult to set, since biological restoration is not an exact science and is unlikely to proceed according to a rigid time frame. Restoration is like a natural process which is affected by many elements including, for example:

*Regarding the restoration of Huai River, one opinion is to clean the water in the river. However, the word clean is not an accurate concept for river management, it is not a quantitative concept as to the degree of the cleaning and the objects of the cleaning. (Shall we) clean (it to) Class I water (standard) or to Class IV water (standard) is still a question. It is the same for river restoration. For example, if we want to restore a river to its original status, then we must make sure what is the time considered as the original status, i.e. how many years ago is the water in its natural state? It is not very easy to determine'* (C: 27-35).

- Some of the rivers are unique and we don't have a great understanding of how those rivers function and how they behave even in their natural state. We are not sure whether some of the things we advocate for restoration are sustainable for the long term.

- Extensive human occupation of ecosystems frequently leads to permanent loss of ecosystem developmental capacity and diversity. In a growing number of cases, these losses may need to be accepted as permanent constraints on restoration. However, addressing restoration from a broad spatial perspective, it is often necessary to relax human constraints on system function' (Frissell & Ralph, 1998). That is why some consider that the *'idea of river restoration would be to focus on the first order streams and get them all fenced off and re-vegetated before tackling the highest order streams'* (D: 97-99).
- Some people think that the vision of river restoration may be useful for planning, but is unattainable in most situations (Gippel & Collier, 1998).

The concept of river restoration is defined differently by people from different cultures. The definition should suit the specific conditions of a country at a certain time. It should suit its technological conditions and economic strength, as well as the sociopolitical environment.

In heavily modified rivers, as is the situation for the Liao River in China, the river restoration concept can be interpreted as choosing pollution planning to prevent further damage to the river system in the short term, while conducting some rehabilitation works to enable functions such as habitat availability for river restoration in the long term (see Lucas, Nicol & Koehn, 1999; Kemp, 1998).

This chapter has shown that interviewees believe that it is very important to achieve the twin goals of economic development and environmental protection. In China river restoration goals should be set by stages, meaning the improvement should be achieved gradually. *'If we disregard the reality, the economic and political conditions of the society, the goals can never be achieved'* (L: 45-46). In Western Australia, rivers should be managed 'on behalf of the community to balance the conservation of the natural environment with the competing demands for tourism, recreational, commercial and residential access (Seal, 1995, p.9). The proviso here is that not all streamlines can be restored or developed into fully functioning creek ecosystems (Pen & Majer, 1993).

The lack of systematic integration of economic development and environmental protection goals in policy design and planning is another problem (Spofford, 1995, 1996) which will be discussed in the next chapter.

## **Chapter Six (Theme 2)**

# **Implications for planning: understandings, structures and public participation**

### **Overview**

Planning is a problem-solving and decision-making process. In the case of river restoration, goals are determined primarily by how managers understand the concept of river restoration. Different understanding on this concept, from the two participant groups were presented and discussed in the last chapter. In this chapter, how managers understand planning in the context of river restoration and how a plan is formulated in the two countries will be discussed. The chapter addresses the impact of managers' understandings of the river restoration concept, administrative structures, and public participation on the planning process.

## **6.1 Understandings of river restoration planning**

### **6.1.1 Introduction**

Planning is a process that sets future directions, and in setting those directions addresses problems by providing a framework for decision-making (Kay & Alder, 1999). The future directions are expressed as a set of goals to be achieved within a specified time. The goals and objectives then become the basis for the evaluation of assessment criteria which reflect both human behaviour and needs, and also the biological needs of project species (National Research Council, 1992). That is, when we talk about planning, we are not only talking about the definition of the concept, we also need to discuss the process and all of the elements involved.

In Chapter four, I presented a draft framework for river restoration planning developed at the beginning of this study. At that time, there were few projects on river restoration, or on river restoration planning. The first comprehensive study on river restoration was conducted by the

US National Research Council in 1992, in which the definition of river restoration was given (National Research Council, 1992). Since then, different definitions for river restoration have emerged. In 1996, Larson demonstrated some German experiences of river restoration (Larson, 1996). Meanwhile, some similar projects were initiated and are still in place in North America. But, each of these projects is small in scope or is applied to only part of a large river. Furthermore, little effort had been put into river restoration planning. Some work in this area have been conducted in Australia, America and in some European countries. For example, several papers on river restoration planning were given by Australian researchers in early 1999 (Second Australian Stream Management Conference, 1999). However it is rare to see a project developed on a large scale and it is clear that we are still at the early stage of river restoration and the planning process. Even so, some problems in river restoration planning have already been recognized.

Kapitzke (1999, p.366) has noted that a “planning and design procedure is commonly presented, but is sometimes limited by poor sequencing or failure to recognize key steps”. For example, some projects took pollution management on the project river as a key step during planning and failed to recognize that the pollution control of the whole catchment should be given priority.

It might be argued that there are no technological constraints preventing river restoration planning, which generally should include some basic systems of measures to prevent pollution, the establishment of riparian vegetation, and channel stabilization processes (Jennings & Harman, 1999). Yet planners often fail to address the social, economic and administrative issues involved, leading to the failure of river management.

Alternatively, this study presents some basic steps for river restoration planning which account for different planning approaches in different social, economic and administrative frameworks. Managers, who have similar understandings of the river restoration concept, tend to have similar understandings of river restoration planning, including the goals and procedures.

### 6.1.2 Understanding in an Australian context

First, any kind of river restoration plan, in Western Australia, has to be made in accordance with the State's *Environmental Protection Act 1986 (WA)*. *'This Act overrides all others, it's the one that sits on top of the pile'* (J), which means the Act prevails, although other projects and initiatives are managed according to the requirements of different agencies.

Managers agree that we are in the early days of river restoration practice and *'we don't have a set procedure for river restoration planning at the present time'* (K). There are some river issues which we don't have clear knowledge of today (K & G). However, there are some essential steps that must be taken. Similar ideas on river restoration planning procedures are presented according to recognized stages in the planning process. The first stage of river restoration planning is problem identification.

In this stage, managers try to identify where the problems are coming from in order to work out how to remedy them according to an environmental priority and within a time frame for recovery (E, G & J). It is the stage to

*assess the resources of the river or the wetlands, to be able to get some ideas of the state, such as, what are the pressures on it; and all the factors that are causing it to degrade; what is the value of it, whether it has rare species'* (K).

The second stage involves the setting of objectives. In this stage, managers need *'to scope out what the objectives are'* (G) based on the information available. Also, *'we'd need to map our catchment, and we'd need to know what is there in terms of who owns what pieces of land'*(E).

Furthermore, during this stage not *'only the ecological objective should be set up but also some economic and social objectives'* (G). At this stage, managers recommend that we should:



*look at what sort of social and economic issues would be involved, such as, what sort of government initiatives could be done under some sort of control and how to work with landowners and the community to get them involved in it (E).*

How to '*prioritize where we need to put our resources, what kind of people are involved and, prioritize areas for the investment of work and time and effort*' (K) are suggested by managers as well.

Thirdly, like any kind of river restoration planning:

*we need to be able to audit it, we need to be able to check what is actually happening. So, the process of monitoring would entail revisiting ten years later and re-survey the river ...see a considerable improvement, audit outcomes for different projects (K).*

Due to the limitation of time for the interviews, the interviewee was asked to provide some of the river management project reports that the managers had conducted, to illustrate the detailed technological information required and used in river restoration. From the information given by managers, it is found that technically, the procedure for planning is very similar to the river restoration planning framework presented in Chapter four. Some additional technical information will be given in Chapter seven. Importantly, managers show interest on planning at the administrative level and care more about how planning is affected by the administrative structure and public participation. These aspects will be discussed later in this chapter.

### **6.1.3 Understandings in Liaoning, China**

As discussed in the last chapter, in China river restoration is mainly concerned with pollution control, especially industrial and agricultural pollution. Therefore the main task for river restoration in the short term is pollution control, which includes some '*research on the self-cleaning pattern of a river, transport and transform action of various pollutants and the methods of pollution control [that] shall be carried out*' (A). Managers with different understandings of

the river restoration concept have a similar procedure for planning. Basically, they think that *'river restoration planning should comprise a final goal, a time requirement and detailed plans. It shall be operable... Cost and benefits shall be considered for the optimisation of different approaches, the best approach shall be cost effective, in other words less investment and good results'* (H). In the case of river restoration planning in China, *'special goals are mainly (focus on) water quality and water flow. Landscape of the riverbanks, requirements on water depth and slope requirements for ship transportation can also be considered according to different requirements'* (H).

A number of ideas of river restoration planning were given by Chinese managers. *'First of all, the reasons for making such a plan shall be explained, followed by the basis, principles'* (C).

Some of the managers believe that *'the first thing is to find out the existing problems of the river'* (A). In this stage, the background shall be investigated, including natural environment, social and economic conditions, as well as water pollution status. *'As the pollution of Liao River is very serious, the pollutants discharge conditions of the big pollution sources shall be analyzed to find out the major problems affecting water environment of Liao River catchment. A comprehensive analysis shall be done based on the collected information. Reasons causing the pollution shall be analyzed, too. After that, the pollutant discharge in the future shall be estimated'* (A).

Because of the condition of rivers in China, river restoration objectives cannot be achieved in one stage. For Liao River restoration, some managers recommend *'general goals and goals for each stage shall be determined considering the requirements on the river functions. Some managers think that the specific objective shall be the control and planning of the river according to national quality standards on surface water environment (GB 3838-88), especially the control of the pollutants that exceed the standards such as COD'* (C). Others think *'the goals are first to regain water quantity by ways of river control, especially control upstream, to carry out water and soil conservation activities in the mountain areas in the east and to carry out small region control; secondly to maintain the river banks; and thirdly to recover water quality, i.e. prevent*

pollution' (B). Also in this stage, 'measures and procedures shall be prepared for solving the problem and reaching the goals, together with the estimate of investment and measure of financing' (H).

During planning, management measures for implementing the identified objectives will be prepared, including engineering measures and special policies. Meanwhile, the plan shall be analyzed for its feasibility. And finally the environmental and economic benefit gained by implementing the plan will be presented (C).

#### **6.1.4 Differences and similarities between the two**

Clearly, different countries, like Australia and China, have different economic development levels as well as degrees of pollution, and therefore reflect different requirements for river restoration planning. Managers from both countries agree that no one could achieve river restoration goals in one single step. For a country like Australia, managers are eager to restore a river to its natural condition. While in China, managers consider pollution control a first priority. However, both groups agree that the major efforts on river resources management should not only focus on protecting the existing ecosystem, but also on restoring those that are degraded (see also Whipple, 1996).

From the responses above it can be seen that river restoration planning is more than a research exercise on water actions. Its purpose is to implement principles based on knowledge. River restoration planning should not only focus on the river itself, as is the case for most plans for rivers in China. It should focus on the whole region at all levels with consideration of social, economic and ecological aspects. At the same time, restoration measures should focus on more than natural structures or states, but also on identifying and re-establishing the conditions under which natural states can create themselves.

So, according to the responses from both groups, some basic principles of river restoration planning can be formulated.

- The balance principle - keeping the balance between the goal of river restoration planning and the current economic development capacity;
- The legislative principle - ensuring the purposes and tasks of river restoration planning are regulated by some form of environmental law. In China, the “Water Law” should be given priority. In Western Australia, the Environmental Protection Act provides for Environmental Protection Policies (EPP), which can be used to help formulate and implement river restoration plans.
- The practical principle - which means the objectives should be practical and supported financially and technically to enable the goals, which should be measurable, to be realised. Priority should be given to the key problems and to solving the problems step by step.

Based on ideas of river restoration planning from the interviewees, the following discussion outlines relevant issues which arose from interviewees and the literature and that are relevant to the framework of river restoration planning. They are presented here and will be synthesized further in Chapter seven.

Before planning, all different sources of funding have to be identified and the procedures to obtain funding, known. After identifying what needs to be done to obtain funding, the following phases should be followed.

### Investigation phase

A broad investigation of natural resources, natural conditions, populations, environmental condition, and social and economic conditions of the whole project area should be taken first comprehensive and accurate information.

In China, particularly in the Liao River catchment, some of the inland lakes are acidified as a result of heavy industrial air pollution. Therefore, 'general planning shall also include air pollution factors. If air pollution really exists, investigations shall be carried out' (L). Further, the current status of the river, including the pollution status is important for such projects in a developing country like China and 'it (pollution investigation) should be carried out to determine the level of pollution' (A). Pollution investigations will provide basic data on which to base pollution controls on the river. It is also important to conduct pollution investigations in Australia, for salinity, nutrients and sediment discharge quantity and loss of native riparian vegetation. The factors that should be investigated have been listed in detail in Chapter four and for the further studies are listed in chapter seven.

### Pre-evaluation phase

Based on the investigation phase, all information should be analyzed to give an up-to-date assessment of the environmental situation. Information can be in various forms and can be analyzed using a number of methods, including geographic information systems and ecological methods.

The "goals of assessment are to identify specific problems, their causes and the restoration potential for each stream reach under consideration" (Jennings & Harman, 1999, p.360).

### Prediction phase

Based on the above evaluation, these results are combined with economic, social and technical development information to make a prediction of environmental development trends.

### Plan-making phase

#### Goal setting

Goals are broad strategic directions that are specified in a plan. For any type of plan, a well-defined goal is important and should reflect the economic and political climate of the area. If managers disregard the economic and political conditions of the community, the goals will be jeopardised. According to all the managers interviewed from Australia and China, river restoration goals should be set in stages, allowing for gradual improvement. Different goals are needed for different projects.

The goals in China might include restoring water quality, benthic substrate, water quantity. In the case of Australia, goals for river restoration would be to restore water quality as well as maintain biodiversity.

#### Setting objectives

Objectives are derived from goal setting, for example, the specific characteristics of water quality to be achieved. For river restoration, the goal is to emulate a natural, self-regulating system that is integrated ecologically with the landscape in which it occurs (National Research Council, 1995, p.18). This includes meeting environmental objectives. In many cases, the development of rivers is impeded by unresolved conflicts between the environment and needs for water resources and economic development. It is clear that the more important aspects of planning and decision-making for water resources and associated land areas should be

comprehensive, in that the key economic and environmental objectives should all be considered (Whipple, 1996).

### Performance indicators

Performance indicators must be developed and linked to each objective. They are specific measurable quantities that reveal to what extent the objectives are being achieved.

### Monitoring and assessment stage

It is known that monitoring of rehabilitation works needs to be undertaken with a clear understanding of the objectives. “The types of water quality and habitat monitoring depend on the specific problems in the watershed” (Jennings & Harman, 1999, p.360). Traditionally, monitoring of water quality has been based on regular sampling of water bodies and analysis of physical and chemical attributes. More recently, biological methods of assessment have been developed (Pearson, 1999).

Monitoring and assessment programs assess progress toward the project’s objectives, goals and mission and require a whole environment approach to monitoring including:

- the condition of the environmental resources;
- all the significant sources of pollutants entering the water system;
- the impact of people on resources; and
- the impact of resources on people.

Evaluation and monitoring may pay large dividends in terms of developing a full understanding of which approaches to restoration work and which do not. The fulfilment of each stage of assessment requires access to adequate data, which is not always available, even in developed countries, and much less so in developing countries where the availability of water quality data are especially limited (Jimenez, Garduno and Domigues, 1998).

## **6. 2 Administrative Structure**

It is recognized that the work of planning, on one hand, should concentrate on the science. While, on the other hand, the art of planning comes with experience and intuition; ‘it has to do with synthesizing all sorts of quantitative and qualitative information—something the human brain does much better than any computer—and putting it all down on a map” (Noss, O’Connell & Murphy, 1997, p. xi). A clear knowledge of the administrative structure for river restoration planning in different countries with different political and economic histories and systems will give managers a clear understanding of what role administrative systems play in each country. It will also help managers to gain more administrative experience of other systems and make planning more efficient and effective. It may also reveal why a plan can’t be implemented completely or efficiently even though the plan itself is good. For example, inefficient co-operation between government agencies or the community can have implication for effective planning and implementation.

### **6.2.1 Administrative structure in Western Australia**

In Australia, some rivers and sections of rivers are managed by a single agency or agencies in partnership with the community, but no management responsibility is assigned to that community. It has been argued that adequate management by some nominally responsible managers does not necessarily occur (Western Australia Water Resources Council, 1994). Often there are a number of agencies involved, but the level of cooperation is inadequate (Grigg, 1996), which doesn’t make life easy (E). The agencies involved in Western Australian river management and their main functions are shown in Table 7.



**Table 7 Main agencies responsible for planning in SW Western Australia**

<i>Government agency</i>	<i>Main functions</i>
Environmental Protection Authority (EPA) and Department of Environmental Protection (DEP)	<p>The major role of the EPA is to ensure the environment is protected when development decisions are made.</p> <p>The DEP is the main service department of the EPA (WAEPA, 1998).</p> <p>The DEP provides advice and administrative support to the EPA (G).</p> <p>Neither the EPA nor DEP make river restoration plans but provide assessment to the agencies who do.</p> <p>The EPA, with the MfP, WAPC and local government authorities, is a proponent of planning schemes and amendments.</p> <p>The EPA, with the MfP and WAPC, is an adviser on planning matters (WAEPA, 1998).</p>
Ministry for Planning (MfP) and Western Australia Planning Commission (WAPC)	<p>The MfP is a public sector agency committed to the proper planning of land use (MfP, 1996);</p> <p>The WAPC is the decision-making authority responsible for guiding the future development of Western Australia. ‘It aims to provide leadership, be forward thinking and offer innovative ways to plan and manage the State’s land use and resources’ (WAPC, 1996, p. 3).</p> <p>WAPC works ‘a great deal with other agencies and for the community’ (E). In terms of putting some private property into public ownership, it is the planning commission who has the power to acquire such things as land (E).</p>

Water and Rivers Commission	<p>Has responsibility for the management of water resources while they are in the actual environment as well as licensing water users (K).</p> <p><i>'WRC provides the sort of technical information that people require at other government agencies, local government and community groups to manage waterways, which includes estuaries, lake systems and rivers' (K). 'Also, it provides technical support to catchment coordinating groups, of which there are a large number, involved with government agencies and community to manage waterways...then right down to individual sub-catchment groups who are doing works on the ground' (K).</i></p>
Department of Conservation and Land Management (CALM)	<p>CALM has a range of functions: forestry (Forest Management Plans); day to day management of natural parks and state forests:</p> <p>Forest Management Plans are reviewed by the EPA (G);</p> <p>CALM is a key provider of expert advice on conservation and bio-diversity issues during the environmental process.</p>
Agriculture WA	<p>Makes comments on effects/documents that may have impacts on Agriculture (D &amp; E).</p> <p>Has the right to/not to promote a plan made by other agency/agencies, such as WAPC (D).</p>

The number of agencies involved in river restoration requires cooperation and coordination through the planning, implementation, evaluation and monitoring phases.

#### 6.2.1.1 Planning

All government agencies that have a stake in particular issues, should be involved in planning. They have their own data or policy position, which needs to be incorporated into the planning process. Often the best way to facilitate cooperation between agencies is to nominate a lead

agency in the planning process, to ensure the process will happen. Leadership should be given to some special agency because:

*it is difficult if you have a large group of different agencies all with some sort of a role or another to focus on a particular set of issues or objectives. If you don't give someone the lead on it, then it can be very difficult to get anywhere (G).*

A steering group should be made up of people with knowledge of local hydrology and familiarity with landowners (Jennings & Harman, 1999), for river management. In Western Australia, Water and Rivers Commission is the lead agency on river restoration planning (E & F), but it does so in association with other agencies (E, D & F). In the river restoration process there is a steering group:

*basically, they co-ordinate across the project area. They keep on top of the latest technical literature and provide the means by which other people can manage the waterways. They also deal with all the conflicts over land uses and in trying to develop best management practices for land uses so that people can effectively manage wetlands and waterways' (K).*

One of their roles is to provide technical advice by which community groups and local government can constitute effective management. One interviewee explains 'we've ... a working group... we meet and discuss how we are going to go forward' (E).

The shortcoming of this kind of planning structure is that other agencies may argue that they should have the lead role (G) resulting in disputes and reduced cooperation. On the other hand, if some agencies are given the responsibility to manage a project, other agencies may say 'well they are better than us, let them do it', and then cease to be actively involved. These problems can be avoided or minimized by ensuring that a steering committee is formed by a range of interested parties and that decision making is by consensus where possible. According to river

managers, *'basically, all the different people involved and take their own share...it is no particular government agency's responsibility'* (K).

It is clear that river restoration is not a project involving only government. Ideally, government will support the community with the best up to date information and funding, and the community may be made responsible for implementing the project. Further, government agencies may work very closely with local government, sharing the responsibilities with well delineated tasks so that everybody knows exactly what their role is and what their responsibility is (K). A clear definition of agency roles and responsibilities also reduces conflicts over jurisdiction.

#### **6.2.1.2 Implementation**

When managers were asked who should take responsibility for the implementation of a plan, some of them said that *'it depends on what sort of plan it is. Sometimes, every department does its own part'* (E). In Australia, there are two tiers of government at the state level, the state government and local government. Generally speaking, the state government does not get involved in the day-to-day operations, these are usually performed by the local government or community groups. Indeed, the groundwork is often done by the community even though the money is from the government (D, E, F & G). The role of the federal government, its involvement with local community groups, and the provision of funds for river management were not explained by the participants although it is clear that this relationship is important.

#### **6.2.1.3 Evaluation**

Evaluation as part of the planning process is usually set up and very often undertaken by an independent consultant who has considerable experience in management (K) in south west Western Australia. *'Sometimes, the consultant can be put on by the Department of Environmental Protection and sometimes by the body that has commissioned the work'* (K).

#### 6.2.1.4 Monitoring

Agencies like the EPA and Water and Rivers Commission, and the public, will take responsibility for conducting the monitoring work after the implementation of a river restoration plan. The EPA and Water and River Commission do most of the monitoring. Agriculture WA and CALM monitor some small sub-catchments. In the Kalgan area, the Water and Rivers Commission are responsible for monitoring of the major waterways (D & G). It is important and beneficial to have Agriculture WA involved in monitoring because that agency has more influence than any other on farming practices. The department's extensive network of extension officers makes it possible for them to let the communities know what is happening (D & E).

#### 6.2.2 Administrative structure in China

In China, the development and management of water resources has traditionally been dominated by the central government; "it was believed that only the state was able to handle the large investment and operations" (The World Bank, 1995, p.100). This idea still deeply affects people's thinking in China. Managers tend to think that:

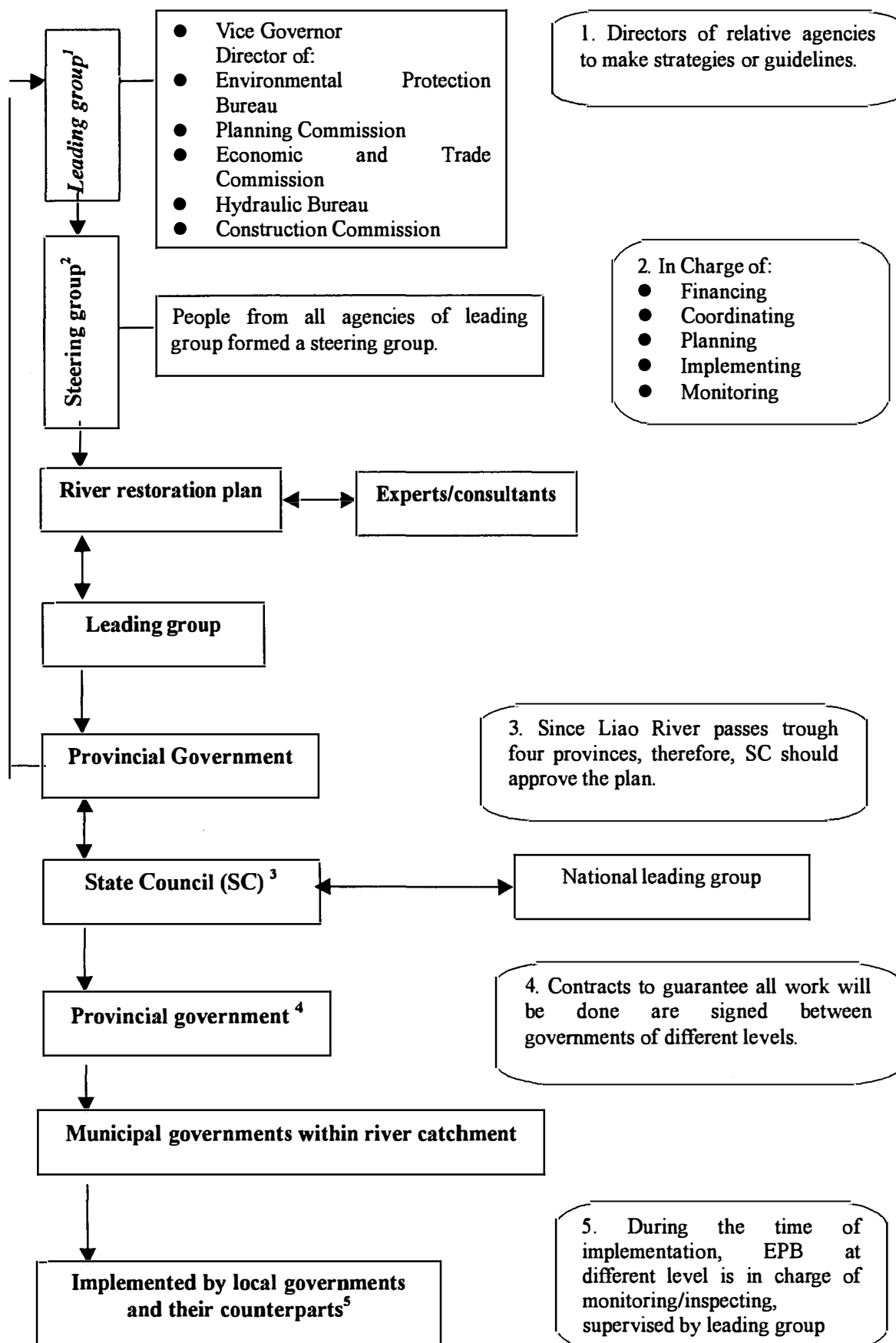
*[a] river restoration plan shall be an action plan implemented under the leadership of the government. It is a government work program, not a research project. ... I think environment protection, planning, finance, irrigation and the superior authorities of all related industries should participate in the preparation of such a plan. In China, the government is responsible for the implementation and organization of a river restoration plan, and Environment Protection Bureau is responsible for overall institutional supervision of the plan (H).*

In fact, in China, the government usually acts as a main driving force of river restoration planning.

In China, the Environmental Protection Plan is formulated as one part of the national social and economic plan. During the time of social and economic planning, all government departments are called to make their own plans. As one part of the Environmental Plan, a river management/restoration plan is made by the State Environmental Protection Administration (led by the National Environment and Resource Committee) at the national level, and at the provincial or local level plans are made by the Environmental Protection Bureau (A, C & L). Normally, goals and implementation tasks are detailed in the plan. Theoretically, for other government departments, environmental protection ideas must be considered as one important part in their planning process (A, C & L) but ultimately it is a process of negotiation and cooperation. It is more difficult to make and keep the balance between environmental protection and social and economic development in China compared with developed countries (C & L).

In 1996, the National Congress decided that three polluted rivers (Liao, Huai, and Hai Rivers), should be taken as key river management projects in China (A, B, C & H). The ninth-five year plan and the Year 2010 plan for the pollution control of Liao River Catchment was made after this decision. Also, according to this decision, the National Environment and Resource Committee developed water pollution control guidelines, policies, goals and tasks for Liao River catchment management (A). River restoration is no longer simply reforestation at an upstream area or the control of pollution discharges at the sources. Since these three rivers are used for many different purposes, comprehensive and cooperative management is needed. One steering group, which is responsible for planning, coordinating and inspecting at the provincial level, has been established for the Liao River management (A & H). The role of the steering group is shown in Figure. 2

**Figure 2 Administrative structure of Chinese river restoration planning at a provincial level**



From Figure 2 It can be seen that river restoration planning in China is mainly lead by the Environmental Protection Bureau (EPB) with a number of other agencies involved. Since *'river restoration is a very big social issue. .. [i]t is difficult for a single department to plan and coordinate such a big project'* (L). Therefore, *'according to formal procedures, environment protection, irrigation, construction, sanitation and agriculture agencies shall be involved in the planning and they are led by environmental protection agencies'* (C). But still there are some problems in managing the Liao River. For example, the water of the Liao is used for many purposes and therefore is managed by separate departments or agencies. Because public agencies normally focus on only one type of water use, decision making tends to be fragmented. Therefore, they often fail to address river management issues in a comprehensive and integrated manner. Sometimes, different agencies have conflicting plans to develop the same publicly owned water resources (The World Bank, 1995). For example, regarding water resources management, environmental protection agencies do not have economic benefit as an issue, while other agencies like *'the irrigation agencies have their own interests regarding water selling, fish raising, and so on. Each agency has to consider its own interests'* (L).

In the past, planning was carried out by different industries. The problems of uncoordinated and fragmented decision-making were exacerbated and this is still happening today. It has led to confusion amongst managing agencies and industries. Even the managers are not sure who should make and implement a river restoration plan and how the administrative system works. For example, one interviewee said *'the management of the plan shall be performed by economic development agencies, EP[B] agencies take part in the process as a member for monitoring and coordination'* (H: 57-59) and:

*The implementation of a plan is to be carried out by the government, the evaluation of the plan shall be performed by a joint group organized by the government and consists of environment protection, planning, finance, irrigation agencies and superior authorities of related industries. It would be better for the public to join in. but in China, public participation is not emphasized'* (H: 129-133).



Another interviewee said: *'the provincial government is responsible for the supervision of the implementation of the plan. The provincial government assigns each agency with detailed work, and evaluates their implementation results'* (C: 78-80).

When I asked a third manager how the system works, he said:

*The formal procedures shall be like this: a planning group shall be established at the beginning, consisting of representatives from various agencies. The environment protection agency takes the overall responsibility. After the plan is prepared, the implementation shall be performed by all the agencies involved. But under abnormal circumstance, with limited time, EPB has to prepare the plan first and then asking for approval from various agencies* (A: 73-78).

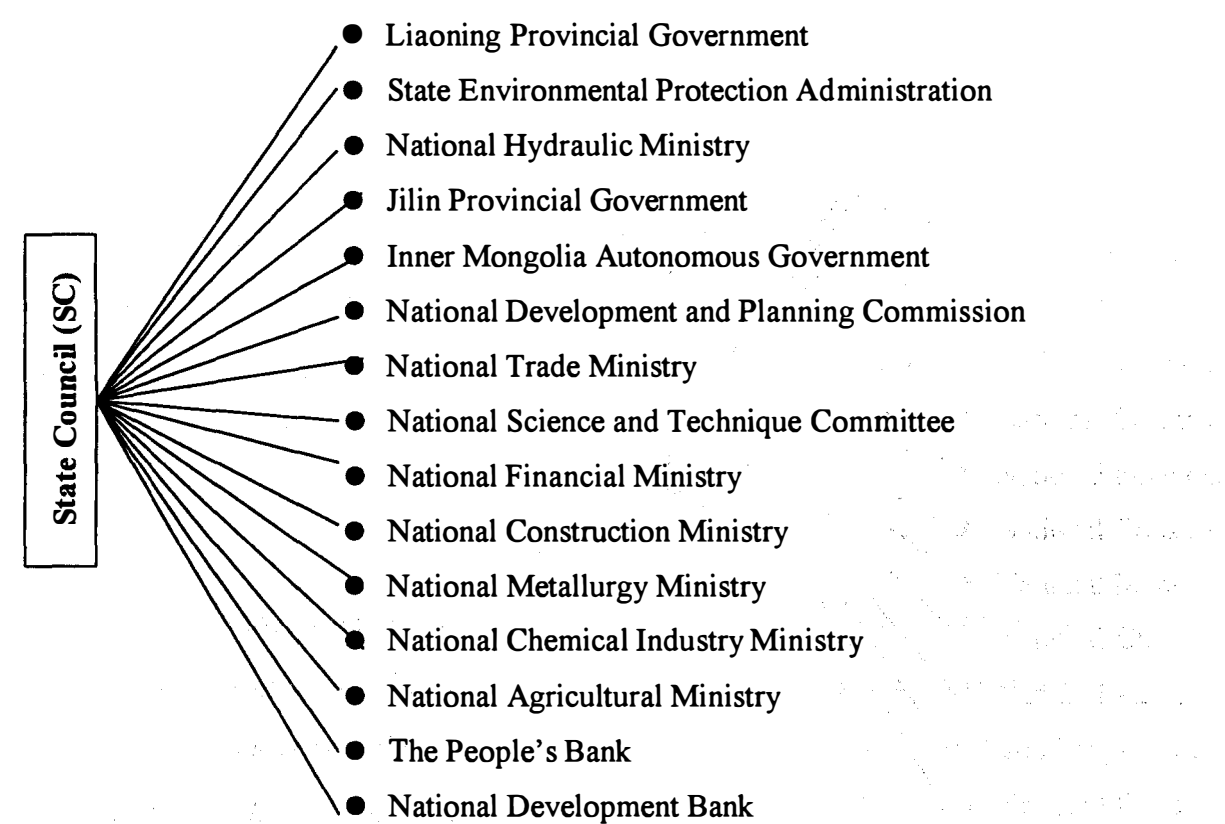
A fourth manager said:

*Environment Protection Bureau is in charge of the preparation of the restoration plan...the implementation of the plan shall be jointly carried out by all the above-mentioned departments. Environment protection and irrigation departments are in charge of the monitoring of the implementation. As planning is done by them, the control shall also be done by them. For example, if the river is polluted, it's the responsibility of the environment protection department. Besides planning, the environment protection department is also in charge of the monitoring of the implementation of the plan...In case of great importance, the plan shall be approved by Peoples Congress and Planning Committee with the presence of representatives of all departments'* (B: 225-237).

The interviews above clearly articulate the government management of the Liao River. It is evident that no single organization has comprehensive responsibility for river management or restoration. The central government has established and coordinated one leading group, the Liao River Management Group. It is an independent organization that has the ability to provide the overall management strategies within the catchment. Also, it has responsibility for reviewing and

recommending changes in investment and management for Liao River. The members of this group are from different agencies at national level (Figure 3).

**Figure 3 Organizations involved in Liao River management planning at a national level**



From the above, it is apparent that the government is the main planning body. However this situation is changing since the introduction in China of the market economy. Now, current policy in China is *'each enterprise is responsible for controlling the pollution caused by itself'* (C). If it causes pollution, it is the enterprise itself that carries the greatest responsibility for pollution control. Government may provide some help to ensure the pollution is completely controlled. In the past, a planned economy was the policy and the government was responsible for all the pollution control. Now, the government assists the enterprise to seek foreign loans and the loans often require an environmental impact assessment (EIA) which helps to ensure that development has the minimum impact. If the enterprise obtains finance from a loan within China, the government will pay the interest for the enterprise to encourage them to control the pollution

themselves. Repayment of the loan is the responsibility of the enterprise itself (C). At the same time

*the project is assigned to each city, and the city governments are responsible for detailed implementation. The project is implemented by city government and overall managed by provincial government. Environment Protection Bureau is one of many operational units, other units include the Agricultural Bureau, who are in charge of the application of pesticide and chemical fertilizer; Irrigation Bureau, who are in charge of water and soil preservation; and the Construction Bureau, in charge of the building of waste water treatment plants. The Liao River Management Office is in charge of the supervision of the project (Liao River management projects) implementation and it is responsible to the Liaoning provincial government' (C: 84-91).*

### **6.2.3 Comparing the two structures**

It is not the purpose of this study to say which of the two planning systems is better since they are implemented in countries with different economic and social development systems. Nevertheless it is worth presenting some detailed information on river restoration planning from both countries in order to learn from each.

#### **Similarities**

From the study it has been established that in both Australia and China, '*the government's role is to disseminate funds*' (K: 267). They provide financial support to river restoration and initiate the first step of planning. Further, the two countries share some similar problems regarding planning, which include duplication of responsibilities across departments, data sharing and inter-departmental cooperation.

Like most countries in the world, Australia and China have a multiplicity of public agencies and commissions with overlapping responsibilities for managing water resources including rivers.

There is a lack of or difficulty in accessing data during river restoration planning due to the administrative structure that exists in both these two study countries. People in different agencies develop different data for their particular purpose (G). If an agency is not heading the project, and even when it is, it is very difficult to have access to data held by other agencies. Managers noted that it is not common to share data among different departments or even groups within the same agency, unless you want to spend extra money (D & G), otherwise, you have to spend extra time to get your own data. Managers need to consider this issue at the beginning of the planning process, by, for example, introducing a system of custodianship of particular databases of all the agencies involved in the project to ensure access to river restoration planning information.

River restoration planning in both countries is also limited when government agencies don't agree or cooperate with each other because of different departmental priorities. This affects the quality of the river restoration planning process and outcomes. From my personal working experience, in China, I have found some industry agencies still think that it is not their business to consider the environment. They have their own priorities, like, for example, an economic priority. If something goes wrong, they claim the EPB should take responsibility, even though it is well known that the EPB itself does not cause environmental problems. The lack of cooperation sometimes results in a single agency dominating the planning process in China. For example, if a plan were needed urgently, it would be prepared by the Environment Protection Agency/Bureau alone. Although the plan will be sent to other relevant agencies for their comments or advice, the lack of participation from all agencies results in incomprehensive or underdeveloped planning. Occasionally, comments from other agencies will not be given or given late, causing more misunderstanding or dissension between agencies. Comments like *'the environment protection agencies of our province have carried out many work, while other production agencies can do nothing about the pollution'* (B: 101-104) indicate the carelessness or irrelevant excuses used by other agencies who do not feel a part of the planning process. These kind of beliefs are, unfortunately, still in the minds of some managers. These attitudes and beliefs will have an effect on the overall planning process.

## Differences

Two major differences between the Australian and the Chinese approach to river management concern the role of the lead agency and the economic systems of the two countries. As I noted above, in China, the EPB is the main body that formulates river restoration plans and then asks for comments from other agencies. In Western Australia, the EPA/DEP is the department that receives proposed planning documents from the various agencies that are involved in river restoration planning and gives comments on them. The existing structure in China is an efficient means of administering river management. The disadvantage is the lack of broad expertise to cater for all types of plans required, which can limit the range and quality of plans. Further, those who will have responsibility for implementing the plan, lack ownership of it. The need for comprehensive planning and coordination in China is now greater than ever (Whipple, 1996). Many Chinese managers strive to have a DEP/EPA equivalent where the EPB supplies only strategic guidelines, makes policies and regulations and gives comments to other plans.

In Western Australia, river restoration is done in association with the Environmental Protection Act and ideally all the agencies contribute with their expertise. The departments that are directly involved have authority to deal with the developments in their region. Since they are responsible for the management plans from the outset, they are better able to understand and to implement them efficiently.

China is currently experiencing a period of change, from a planned economic system to a market economic system and consequently, there is instability within administrative and planning structures. Therefore, it is more important to have access to experience from overseas to assist Chinese managers to make efficient plans and to avoid mistakes from inexperience. China is also experiencing a period of reform within its administrative system.

### 6.3 Public participation

As a result of intensive human activity over the last hundred years, most of our river systems have been heavily modified, resulting in aquatic ecosystem degradation. At the same time, “environmental concern from public and scientific communities regarding stressed and degraded river system is growing rapidly” (Wade, Large & Waal, 1998, p.1).

Public participation is a process in which stakeholders influence policy formulation, planning, investment choices, and management decision making (The World Bank, 1995). Further, it has been found that “successful projects begin with one or two cooperating landowners who have strong interests in stream restoration and who are willing to try innovative approaches” (Jennings & Harman, 1999, p.360). The ways that government communicate with the public, industry, the community or individual people differs between departments and agencies or in different countries according to their needs and working situation.

#### 6.3.1 Participation in south west Western Australia

Generally speaking, the government in Western Australia encourages and expects participation from the beneficiaries and affected parties in the planning, implementing, and managing of river restoration projects. *'Individual landholders in each catchment are also encouraged by government to do positive things in regards to land use and river management planning to ensure that rivers will survive in the future'* (J). In these situations, and in accordance with the policies of each department regarding public participation, *'managers can be swamped by the comments from the public'* (E). Reviewing and analyzing public submissions can be quite time consuming but worthwhile, since these comments can provide new information and ideas on how to manage issues and problems. *'Plans are usually changed based on public consultation. Sometimes dramatic changes are made'* (E).

On one hand, government attitudes to public participation are quite positive. In Australia, at least, *'government is expected to acknowledge anyone who is willing to experiment with river restoration planning, to give people support in kind rather than belittle them or make them look silly'* (F). Further, managers acknowledge that the public are more likely to accept a plan as valid if it is made public to stakeholders. They will resist government bodies who make a plan for their land and tell them to implement it. People are more likely to follow the plan if they are involved in the process (G). In one example, about 90 people objected to a plan made by government. The plan was eventually reviewed and was subsequently acceptable to the community because the review involved visiting and explaining, to the community, the need for the plan and the various management operations. Once the comments from the public were considered, an agreement was reached, based on their comments and the plan revised (E). This level of public input is not practical in all countries, however it is a process that has merit. The community in south west Western Australia may receive government assistance, including financial support (K), and partnership arrangements.

The attitudes of the public to river restoration in south west Western Australia are also positive. People generally believe that in a farming area it is up to the farmers to do what is necessary toward land and river management, which may result in some mismanagement or carelessness if the government agency is not guiding the process.

The study found that

*it is the community, particularly in Australia, who actually get out there and do the work on the land, because they feel that they want to see a cleaner river and they want to protect the wildlife, the birds and everything else* (E: 256-259). *[And]there has been over the last eighteen years, the land conservation district committee where a group of farmers get together and try and remedy some of the actions that have happened on their lands* (E 163-166).

Managers also believe that *'it's really the farmers that's got to take the initiative and...in the end take the responsibility'* (F: 44-47). Generally speaking, contrary to popular opinion, instead of doing what ever they want to do, on their private lands, *'farmers take a pride in their farm, their stock and everything else'* (F: 211-212). Most of them are intelligent enough to realize that if the land is not healthy or productive the stock are not healthy or productive, and they will not make money. Also their children or grand children are going to lose the land and they won't be able to make a living from it. This is another reason why they want to take responsibility (F).

In theory there should be few barriers to the formulation of a river restoration plan and the implementation of it in a situation where both the government and the public are acting for the same purpose. However, like all kinds of partnerships, the government and the community will not agree in every situation because of free and independent thinking, misunderstandings or different priorities of the two parties. Some managers note that government and the community argue all the time (K). There are often very strong opinions from the public about government decisions and expert opinion. For example, the lack of communication between the government and the public engenders a belief that the government is too bureaucratic, limited in technical knowledge and out of touch with particular areas. Farmers feel that they are not given respect from the government in general, and the government experts see the farmers role as just there to grow things (F). Farmers hope for some agreement during the planning process, rather than regulations and rules, which affect farmers, being made without any consultation. Both the managers and the community believe that education and persuasion would achieve more than waving a big stick and telling people what they've got to do (D, E & F). If agreement can't be reached through negotiation, then some vocal actions may be taken by the public, like placing an advertisement in the paper, holding public meetings and protesting. Through these actions, farmers lobby for a greater voice, support or a particular result from the government.



### 6.3.2 Participation in China

Unlike Western countries, in China, the public is usually not involved in environmental management planning, even though the increase in media coverage of pollution accidents has contributed to the public's awareness. In China, there are still a lot of managers who think that public participation can only be effective when the social, economic and cultural development have reached a certain level (L). Also, because they perceive that China has its own special conditions, they argue that plans should be prepared by the government (C). They argue that it is impossible for the Chinese government to take an approach like the Australian government has taken for public consultation, because,

*it is not only impossible to give every person a copy of plan, but also the common people do not care very much about environmental issues and no one has ever done this before in history (C: 131-133). [And] because the environmental awareness among ordinary people is very low, the legal representatives of the enterprises are not interested in the environment plan, let alone common workers and farmers (C: 133-135).*

Throughout the study, I have given some basic reasons why public participation is not significant or popular in China. The attitude of Chinese managers to public participation is also revealed. For example, during planning *'real workers or farmers will not be invited. Government owns lands and factories (in most cases)'* (L: 231-232). Further, *'in China, river control depends on the government, people will follow the governments orders ... For example, (when) the government orders to clear the river course, farmers can only follow despite their wills'* (B: 275-279). In this kind of situation, *'once the plan is prepared, the related enterprises will be informed of the objectives of the pollution control. Although opinions are collected from the enterprises, normally they just do as they are told'* (C: 100-112). The public are not given management rights simply because they are not the owners of lands or factories.

Further, the level of the public (environmental) knowledge is considered relatively low (L) and *'the public does not participate in the management purposely/spontaneously, but to defend for their interests'* (A: 213-214).

Even when governments do consult, policies on planning in China, and possibly in other countries, will only advise people as a group not individually (C & F).

*During the planning, not every enterprise is involved. It does not much matter, only the superior authority, like Economy and Trade Committee (ETC), is involved. The ETC is the leader of industrial and commercial enterprises. If the ETC agrees with a plan, we can say that the enterprises also agree with the plan. The enterprise has no rights to pollute. They will do their best to achieve the objectives assigned to them. Also, these objectives are normally reasonable and the government will try many ways to solve the difficulties faced by the enterprises* (C: 116-122).

*Although a plan is published after it is formulated and approved, it is only for reference of certain related agencies. Common people do not have access to this plan. A plan is not shown to the public only to the government. In our country, the river control plan is not confidential to the public. It is not shown to the public because of two reasons, one is that public awareness and knowledge are not high enough to understand the plan and secondly the government personnel do not want the public's opinion* (B: 242-247).

From the above we can see that there is very little stakeholder input into the planning process in China. Practices are, however, changing since many environmental problems occur even though the government has invested considerable money and labour into various river management projects. Many government representatives realize that without public participants, a river restoration project cannot be implemented well. Depending on the social context and local conditions, public participation can progressively increase in intensity over the project cycle, from consultation at the planning stage to the actual operation and management of the project

(The World Bank, 1995). However, the difficulty comes with raising the environmental and resource awareness of the public. The importance of education is recognised. In China, *'many big issues are determined by the government'* (L: 259-160), the implementation of birth control has achieved great success. *'The population control plan is implemented very well in China, just because public is involved in planning and implementation'* (L: 251-253). Therefore, more and more people think that *'the management shall be shouldered by the whole society, it is everyone's responsibility'* (A: 134-135). And although public participation in environmental issues is not yet possible in China, however, in the planning phase, *'some representatives from people's congress will be invited. This is called organized participation'* (A: 216-217). But because the agricultural population is huge, it takes time for the farmers to absorb advanced knowledge. For this reason many people think *'government shall provide guidance to the agricultural production'* and why *'government shall enforce the publicity and education to help the farmers'* (B: 156-159).

### 6.3.3 Comparing public participation in the two countries

The public in south west Western Australia is not only involved in river restoration planning but also in implementation. Although they are working towards it, this is not the case in China. It is easy to understand why there is not public participation in river restoration or any other kind of environmental management in China. As a researcher with a Chinese working background, I personally agree that it does not happen *'because the economic conditions of the public is not very high, the environmental awareness of the public is low and the political management system is not suitable'* (A: 219-221). What I will not accept, however, is the view that *'they (the public) would not give any useful suggestions as they are limited by their knowledge level'* (A: 222-223). If government keeps ignoring the opinions from the public, of course, they will not say anything. If the public knows that they will not be listened to, they will see no point in caring for the environment or in expressing themselves. More importantly, if a government does not listen to the public or invite them to participate during the planning phase, they will not know what knowledge they have to contribute.

The disadvantage in this system is that the public takes the government's domination for granted. Because of the lack of motivation, they have little awareness of river restoration management. Another disadvantage is that some government agencies tend to impose their will on users to suit their own needs. Although rivers were primarily managed for economic purposes, they now face increasing environmental problems and there are differences of opinion among the various concerned interests (Whipple, 1996). The most important initiative in furthering river restoration planning in China and in any other countries is to increase the communication opportunities between government and public. The Chinese environment can only be managed well when the two parts cooperate with and respect each other. It will take time to raise the environmental awareness of the public, especially in developing countries where levels of education are low, but *'with the raising of the public living standards, with the popularization of education, environment awareness will be improved'* (A: 227-229). It will also take time for all the managers to realize and understand that in order to plan and implement river restoration effectively, public participation is very important and if managers cannot convince the public after planning, it probably was not the best way of doing it (F).

Another difference in public participation between Australia and China is the number of community groups with a high level of environmental awareness in Australia compared with China. These groups offer several opportunities for the public to be involved in restoration projects as well as communication and education opportunities. In China, it is rare to see environmental community groups, especially in the countryside.

#### **6.3.4 Promoting public participation in planning**

I believe that there is a big gap between the stakeholders (like farmers and workers) and bureaucratic experts in both Australia and China. The reason why plans are poorly formulated and implemented, and why the public are not satisfied with government decisions is that managers distance themselves from the public and the stakeholders. Stakeholders learn from

practical on-the-ground experiences, while some government managers use their knowledge learned from textbooks at university may not notice the detail problems the stakeholders have to face everyday during the time of planning. It should be noticed that different approaches affect the implementation of a plan and it is very important to get all parties in the planning process together to share their knowledge and experiences in order to develop a workable plan.

The research revealed that only a few interested parties provide input into river restoration or management planning both in Australia and in China. Most care little for the process and they lack environmental awareness. Some of them *'in some ways are arrogant and conceited'* (F: 387), they don't want to listen to anyone. How can public knowledge be increased and public interest in environmental projects be stimulated? One interviewee suggests the problem is conceptual. *'Something if you can't physically see, it's very difficulty to deal with'* (D: 257-258). Therefore, demonstration projects should be set up to show the public what kind of improvement they can achieve through river restoration. At the same time, governments should try different ways to keep informing, persuading and gradually educating people, otherwise, they will not become aware of the problems nor what is being done.

It is important to have the public involved in river restoration planning, however, realistically, no plan can satisfy every one. We must accept that *'we will never get the cooperation of everybody'* (D: 217). River restoration planning is not a case of hoping to satisfy everyone. *'It's really a matter of the process being open and transparent'* (G: 139). To make the process effective, someone has to make a decision by the end of the day based on the comments from different government agencies and the majority of public opinion.

### **6.3.5 Problems in the planning systems of the two cases**

Some issues in river restoration in Western Australia arise from misunderstanding and lack of communication between the government and the public or particular communities when managers don't agree with each other. Government agencies may not agree with each other all

the time. Sometimes the different approaches to river restoration projects, by government departments and the public, conflict because neither group knows or can understand the other's perceptions or needs.

#### **6.4 Recommendation**

The relevant water-related agencies should coordinate and agree upon priorities and policies for investment, regulation, and allocation of resources, especially for the management of the river catchment (The World Bank, 1995). If this kind of coordination cannot be achieved, it will be impossible to integrate environment and development issues at local and regional levels where most decisions affecting the environment are made (Spofford, 1995).

Coordinating committees or steering groups could be established similar to the working groups in China and Australia, with representatives from major public water agencies or organizations who have an influence over, or interest in, river management. The committee has responsibility for reviewing and recommending changes in investment and management.

This kind of committee or group should be the centre for negotiations and policy-making at the catchment level. It should also be a centre of technical expertise and knowledge as well as the primary planning institution for river management (The World Bank, 1995). The expertise within the committee/group should encompass river ecology, landscape ecology, public perception, planning, fisheries, biology, water quality, fluvial-geomorphology and river engineering (Holmes, 1998).

It is important to develop methods of establishing partnerships for structured collaborations for river restoration between institutions and interested landholders with differing powers, resources and responsibilities but who share a common aim of improving rivers (Holmes, 1998, p.135).

In south west Western Australia, river restoration plans are not only made by government agencies, at times they are made by different community groups. For some special projects, communities implement their projects with their own plans and with support advice from government (F) to ensure the plans are appropriately prepared and do not conflict with government policies.

Alternative designs for river restoration should be made by a responsible group which has members from all the relevant agencies and community groups. *All the information of the designs should be sent to relevant agencies as well as all the stakeholders and try to get feedback as much as possible* (G). Their feedback should be promoted at government level and finally, the government should *'promote the whole thing with the community'* (K: 201-202). At this stage, *'there's a need for a communications strategy and a promotion strategy'* (K: 202-203).

## **Chapter Seven**

### **Synthesis—Framework for river restoration planning**

#### **7.1 Limitations and recommendations from the study**

In this study, a qualitative method was used to reveal managers' understanding of river restoration and its planning. Because of the time constraints, the study could not include quantitative methods. Therefore, no statistical figures on the percentage of managers who accept the restoration concept were obtained. A more detailed result could be generated if a questionnaire was designed and sent to a larger sample of managers. It would provide data for conclusions on the perception of managers regarding the acceptability of river restoration.

Further, because of the time constraints, the research deals with a framework for river restoration planning, but does not apply it in depth to case studies. The application of the framework to case studies would test its strength for planning for a river restoration process.

Noting these limitations, further studies, based on the result of this study are recommended. For example, the results of this study can be applied to a questionnaire and sent to more river managers to test the accuracy of this study. Alternatively, future research could be conducted by applying the data from a project river to the results of this study. Also, the plans of different case studies could be examined using this framework to test the robustness.

#### **7.2 Different interpretations of the river restoration concept and planning**

In chapters one and four, I introduced the definition of restoration concept given by the National Research Council, which is “the return of an ecosystem to a close approximation of its condition prior to disturbance” (National Research Council, 1992 p.523). Based on this and other definitions from the literature, I have developed and introduced a framework for river restoration planning, which was used as a framework to be compared with the understandings and



experiences of river managers in two different countries. The understandings of river restoration, river restoration planning and the elements affecting them were presented in Chapters five and six.

In this chapter, I present some different interpretations of the river restoration concept according to the understandings of river managers interviewed. I present the differences in approaches to river restoration planning. Through this study, I found that the river restoration concept was interpreted in different ways and was influenced by social, economic and ecological situations. It also was found that people with different understanding of the river restoration concept have different goals but adopted similar procedures for river restoration planning and the procedures were similar to the framework (see Figure one). Therefore, I will not repeat the procedure of river restoration planning. A new framework for river restoration can be considered as a combination of chapter four and some ideas presented in this chapter.

All the river managers who were interviewed regard river restoration as a process with goals that can only be achieved step by step. This study also found that planning is influenced by the administrative structures for river management, and by public participation in river management planning.

River managers in two countries, Australia and China, were interviewed. In general, in Australia, it is accepted that the pre-disturbance conditions would normally be interpreted as the conditions existing just prior to European settlement (Gippel & Collier, 1998). For a country like China, with more than 5000 years of history and a large population, it is almost impossible to find pre-disturbance data for comparison.

### **Two systems and two approaches to planning**

In Australia, river restoration is understood as a process for restoring the river system to an improved condition, to reach the right balance for maintaining biodiversity. For the Kalgan River

which passes through an agriculture dominant area, the main water system problems are salinisation of inland waters (which is also a common problem in areas where agriculture requires irrigation) (Kemp, 1998), the loss of natural fringing vegetation, eutrophication, sedimentation and contamination of inland waters. Managers see river restoration according to the kind of ecological benefits people will derive from it. Based on this understanding of river restoration, the main goal is to maintain the sustainable development of river system.

In China, most rivers, including the Liao River, have been heavily modified and polluted. Therefore, river restoration is interpreted as water quality control and quantity recovery to meet the river functions. Managers in China believe that it is difficult and unnecessary to return a river to its undisturbed state. Therefore, in river restoration planning, pollution control is considered to be the first crucial step for river management, and the prevention of further damage to the river system is the primary goal in the short term. At the same time, rehabilitation works to improve functions such as habitat availability, are the goals for river restoration in the long term (see Lucas, Nicol & Koehn, 1999).

In both interpretations, river restoration should cover actions like forest conservation, protection and planting. Some other actions to enrich the water flow by way of water and soil conservation should be included as well.

### **7.3 The basis of difference in river restoration planning**

Some researches show that “many of the developments that have caused degradation of Australia's waterways have been government sponsored” (Gippel & Collier, 1998, p.274). Based on this finding, river restoration planning should be a process that crosses government agencies and local government, and that depends on the community (particularly land owners in Australia) to develop solutions to problems at a local level. Hence the attention, in the study, to

the administrative structure and to how inter-governmental processes work and how public participation in river restoration planning is structured.

From the study, it has been found that river restoration is a process that requires the involvement of all stakeholders. Further, it is a process that requires a balance between ecological, social and economic issues. River restoration also requires the commitment of resources, particularly economic and the personal commitment of time. It cannot be achieved without the involvement of government, community and individuals, who each acknowledge their responsibilities.

The study indicates that government at all levels, industry and the community generally must work together to prevent or minimize further degradation, and to coordinate river restoration planning together. River restoration is a process of restoring a river or watershed to a condition that relaxes human constraints on the development of natural patterns of diversity. It should be a process that improves the conditions in and around the stream channel so that natural functions are restored.

Finally, the interpretation of the river restoration concept and its planning should suit the specific conditions of a country at a given time and according to cultural requirements. The planning should be suitable for the technological conditions and economic strength, as well as the social/political environment. I hope that this study will provide a common starting point for the process of river restoration planning.

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## **Appendices**

**Appendix A: Interview Guide**

**Appendix B: Consent Form**

**Appendix C: Interview Questions**

**Appendix D: Categories**

**Appendix E: Map of the Liao River in Liaoning Province**

**Appendix F: Map of the Kalgan River**

## **Appendix A: Interview Guide**

Dear Participant:

My name is Ye SUN. I am a Master's student of Environmental Management at Edith Cowan University, Australia. My Master's project will try to develop an appropriate framework for river restoration planning for the Kalgan River.

I would like to conduct an individual interview with you and about 5 other persons working in different departments of state government and community groups of WA. Your opinions will be used to examine whether the concept of river restoration and a framework is suitable for the Kalgan River.

The information I will get from you will remain confidential. Your name and department will not be mentioned if you feel uncomfortable; your opinions will not be regarded as the opinions of your department or that of the state government or your group. I am expected by my university to keep the information for up to five years.

I intend to audio tape our conversation. Please indicate whether you agree to this on the consent form. If you feel uncomfortable, I would like to take notes instead.

As a participant, you are not required to give any detailed data of the Kalgan River if you don't want. I'm only interested in your perceptions of river restoration and your attitudes about river restoration of the Kalgan River. And what type of framework for river restoration, do you think, is suitable for the Kalgan River. One purpose of this study is to develop an appropriate river restoration plan for the Kalgan River based on your opinions and the opinions of others.

All the questions you will be asked are included in the Interview Guide.

If you have no objection to being interviewed or if you have any questions about my study, please contact me at this address:

Address:

[REDACTED]  
Edith Cowan University  
100 Joondalup Drive, Joondalup, 6027  
Perth, WA

or call: [REDACTED]

Or Email: [REDACTED]

Hope to hear from you.

Yours

Ye SUN

Edith Cowan University  
Perth, Australia

## Appendix B: Consent Form

I, \_\_\_\_\_, have read the information above and have been informed about all aspects of this study.

- I agree to participate in this study and realise that I may withdraw anytime.
- I can stop the interview at any time.
- My responses to this study will not represent any other person.
- My responses to this study will not be the official responses of my department or of the state/provincial government.
- I have the right to check the transcript of my interview.
- I know that if this study is published that maybe my name will not be identified on the transcript, and will not used in published materials or draft report.

Please tick if the interview should be audiotaped.

**YES**

**NO**

**Participant:**

**Date:**

**Investigator:**

**Date:**

Thank you very much for your participation.

Ye SUN

(This form will be supplied to participants in Chinese and in English.)

## **Appendix C: Interview Questions**

### **Part A: Background**

- *Please give a brief description of your role in the department.*
- *Have you ever been involved in any environmental planning projects?*
- *What role does your department play in environmental planning?*
- *Have you ever been involved in a river restoration planning project?*
  - *If no, please go to Part B*
  - *If yes, what projects? What was your role in most of these?*

### **Part B: Understanding**

1. *Using personal experiences and examples outline your understanding of the concept of river restoration.*
2. *Give a brief idea of the degree/level of planning needed for river restoration.*
3. *If you were a planner involved in a river restoration project, how would you identify the procedural of river restoration planning?*

### **Part C:**

*Please give your comments of this framework for river restoration plans.*

## **Appendix D: Categories**

Understanding of river restoration concept

### ***A: on ecological perspective***

1. Water quality
2. Water quantity
3. Degradation
4. Catchment
5. Bio-diversity
6. Pollution control
7. Fence

### ***B: on sociopolitical perspective***

1. Social background
2. Legislative system
3. Administrative structure
4. Population pressure
5. Policy making

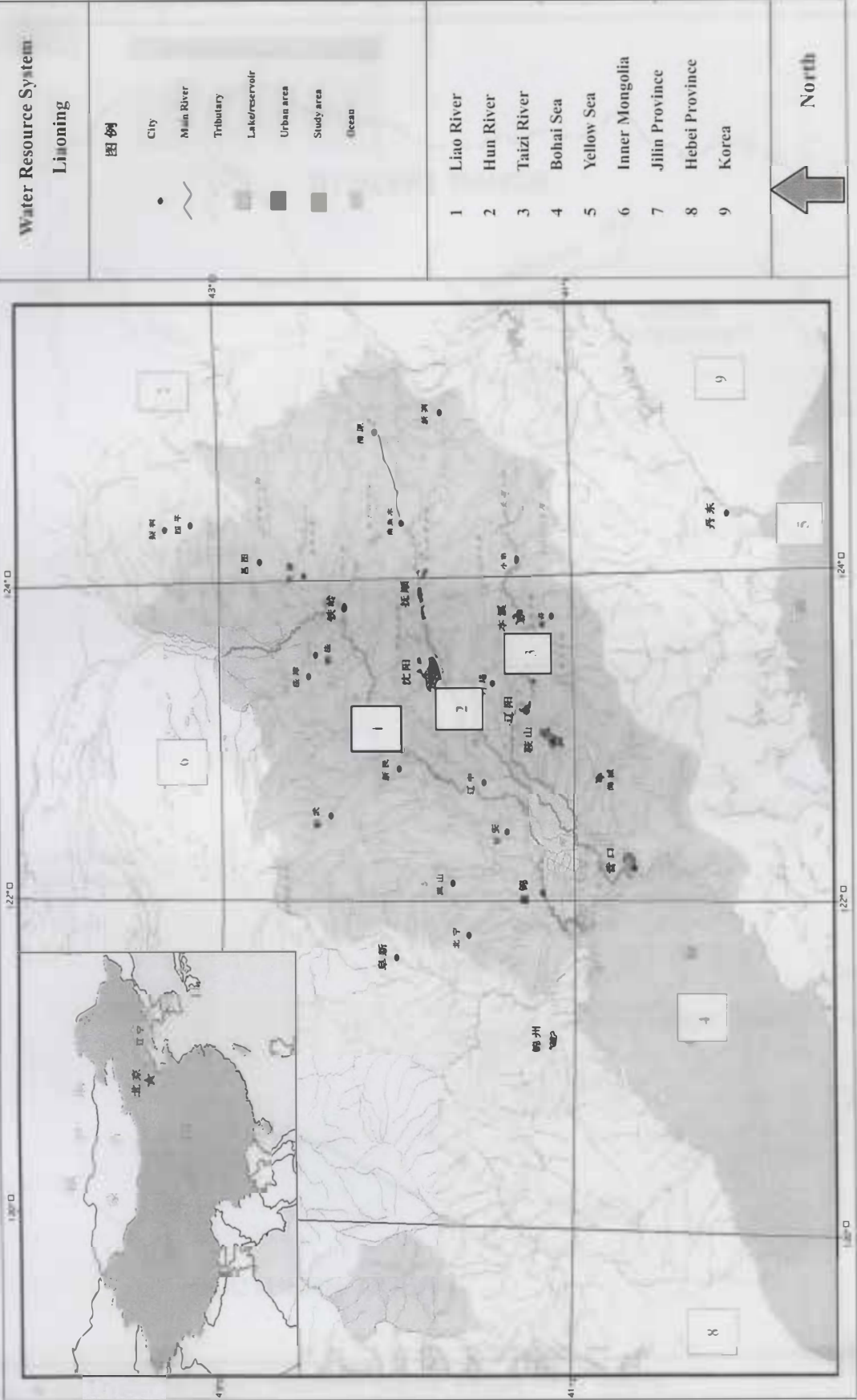
### ***C: on economic perspective***

1. Economic development level
2. Financial support
3. Economic difficulties
4. Policy making

### ***D: understanding of river restoration planning***

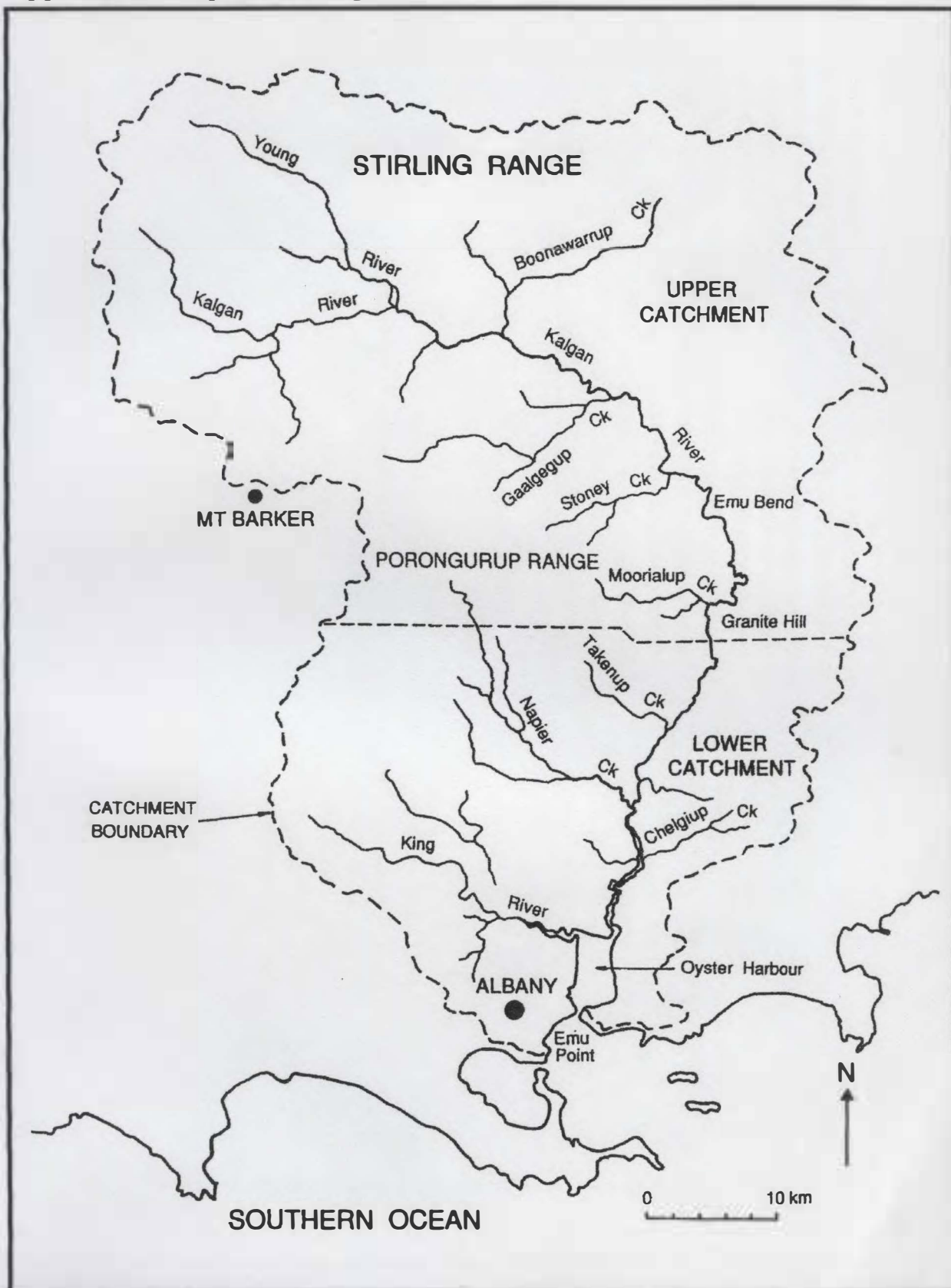
1. Procedure of river restoration planning
2. Administrative structure for planning
3. Steering group for planning
4. Public participation
5. Government functions

Appendix E: Map of the Liao River in Liaoning Province



Map of the Liao River showing the main river systems, features and provinces.  
Source: Liaoning Environmental Protection Bureau, (1997). Functions of Ground Water Systems in Liaoning (in Chinese), Shenyang: Liaoning Education Publication.

## Appendix F: Map of the Kalgan River



Map of the Oyster Harbour Catchment and the Kalgan River system

Source: Pen, L. (1994). The Condition of the Kalgan River Foreshores 1992/93, Perth, WA: Waterways Commission, Report No. 52, November 1994.